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OG AKERSHUS

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Performance of Option Trading Strategies

Evidence for Individual Stocks and the OBX During 2005-2015

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ABSTRACT

In this paper, we examine risk and return characteristics of some of the more popular option trading strategies such as: Covered calls, Covered combinations, Protective puts, Straddles, Strangles and Butterfly spreads. Long stocks are included as a benchmark. We contribute to a growing part of the literature that examines in detail risk and return characteristics of well-known trading strategies; see Eckbo and Ødegård (2015). We also contribute to Hemler and Miller (2015) by investigating a different market and a different time period. Our sample includes the largest stocks on the OSE together with the corresponding options. As implied volatility has been highlighted in prior literature as an important aspect of trading options, we have included this as a signal for a trading rule used for the last 3 of the said strategies. The results are presented in terms of risk-adjusted performance measures, namely: Sharpe ratio, Jensen's alpha and Information ratio. We find that the Covered call is the only strategy the generally outperform the long stock strategy, which in turn outperform the rest of the 5 strategies, and that implied volatility fails to signal the strategies into outperforming the others.

SAMMENDRAG

Denne oppgaven evaluerer prestasjonen til noen av de mer populære opsjonsstrategiene ved hjelp av risikojustert avkastning. Nærmere bestemt - Covered calls, Covered combinations, Protective puts, Straddles, Strangles og Butterfly spreads. "Kjøp og hold" av aksjer er inkludert som en referanseportefølje. Vi bidrar til en voksende del av litteraturen som undersøker risikojustert avkastning av kjente handelsstrategier, se Eckbo og Ødegård (2015). Vi bidrar også til Hemler og Miller (2015) sitt arbeid, ved å undersøke et nytt marked og en ny tidsperiode. Vårt utvalg inkluderer aksjer for de største selskapene på Oslo Børs sammen med tilhørende opsjoner. Siden implisitt volatilitet i tidligere litteratur har blitt fremhevet som et viktig aspekt ved handel av opsjoner, har vi inkludert dette som et signal for en handelsregel til 3 av de nevnte strategiene. Resultatene presenteres i empiriske suksessmål, henholdsvis: Sharpe-raten, Jensen's alpha og informasjons-raten. I vår utredning finner vi at Covered call er den eneste strategien som gjør det bedre enn referanseporteføljen. Referanseporteføljen gjør det derfor bedre enn de resterende 5 strategiene. Handelssignalet som inkluderer implisitt volatilitet feiler i å signalisere strategiene til å overgå de andre.

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PREFACE

This Master thesis marks the end of our financial studies in Business Administration at Oslo Business School. We would like to express our most sincere gratitude to our supervisor Dr. Sturla Lyngnes Fjesme, for his guidance and helpful inputs throughout the semester.

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1 - INTRODUCTION

In recent years there has been an increased focus on the use of options as part of investment portfolios; see Oslo børs (2013) “Alt du trenger å vite om Opsjoner Forwards og Futures”. The Oslo Stock Exchange (OSE) has also made option trading considerably cheaper and easier for investors. In this paper we contribute to a growing part of the literature that investigates risk-return characteristics of common trading strategies, see Eckbo and Ødegård (2015).

In this paper we test risk-return characteristics option strategies on the Norwegian stock market, Oslo Stock Exchange (OSE). Including options in your portfolios can transfer the risk associated with a certain variable away (or include), which in some cases might be very clever. Hemler and Miller (2015) and Kapadia and Szado’s (2007) have both shown that option strategies outperform the simple buy and hold. Our main research question is therefore whether the results from the most popular and well-known options strategies can be transferred to the Norwegian market. To fully cope with the use of options, we have divided our main research question into 3 hypotheses. The first hypothesis focuses on the well-known, and well tested strategies Covered call, Covered combination, and Protective put. The second hypothesis search to explore the more popular option strategies Strangle and Straddle. The last hypothesis looks at the performance of the strategy Butterfly spread, which might be a good choice for the risk averse investor, given its payoff structure with flat tails. Several of the articles this thesis is built upon, which will be mentioned in the section below, have made us aware of the implied volatility in terms of trading options. In addition to testing the aforementioned strategies, the last 3 will also be including the implied volatility as a signal for a trading rule.

Our findings are that the Covered call, in terms of Sharpe ratio, with an average equal to 0,0137 over the entire period of 10 years, are the best performing strategy. Long stock have a average of 0,01187, closely followed by Strangle, with a average Sharpe of 0,01182. Note that the mentioned Strangle was without the use of implied volatility as a signal. On the other side of the results table we find Butterfly spread, performing worst with a Sharpe equal to -0,0147. For Jensen’s alpha, the Strangle and Straddle are the best performers with measures of 0,00016 and 0,00015, respectively. Both of these are without the use of implied volatility as a signal. The worst performer is again the Butterfly spread, with a alpha of -0,00012. The best performers measured in Information ratio is the Straddle, without and with the use of implied volatility as a signal, with measurements equal to 0,01855 and 0,00000, respectively. The Covered call performed the worst with -0,01788. To sum up our findings in words; the strategies does not outperform the long stock, and should not be used, except for the Covered call.

We use data from the time period 2005-2015, which are gathered from Oslo Stock Exchange via the database TITLON. TITLON is a database available for students from Høgskolen i Oslo og Akershus (HiOA), among others, containing both option and stock data. The sample of stocks and options is roughly among the 10 largest individual stocks on the said exchange and we also included the index OBX.

We conclude that there are positive aspects of including options in your portfolio, but the results from the article written by Hemler and Miller (2015) are not directly transferable to the Norwegian market. Covered combination is an example of a strategy that should have performed better according to the results from Hemler and Miller (2015). The strategy is outperformed by several others, including buy and hold. Covered call performed the best measured in Sharpe ratio. The Straddle and Strangle perform well in terms of both Alpha and IR measures, but is not among the best in terms of Sharpe ratio. Implied volatility did not make our strategies become consistently profitable, and several of the strategies performed better without the use of the implied volatility as a signal for when to sell options. The Butterfly Spread is outperformed by all the other strategies across all the risk-adjusted measures that are included in this thesis, namely Sharpe ratio, Jensen's alpha, and Information ratio. Whether or not these strategies should be used is somewhat dependent on the field of application. If the investor is looking for high Alpha measures, the Straddle and Strangle strategies should be considered. Based on the Sharpe ratio measures we conclude that hypothesis 1, 2, and 3 is rejected and therefore the trading strategies should not be used. However, we can recommend using the Covered call trading strategy based on these results, as it is the only one that outperformed the buy and hold strategy. The use of these risk-adjusted measures are inspired by the article written by Eckbo and Ødegård (2015), which we find to be superb in breaking down the measurements.

We contribute to Eckbo and Ødegård (2015) by investigating common trading strategies. We also contribute to Hemler and Miller (2015) by investigating a different market and a different time period. In addition we contribute by developing a new method for testing hypothesis 2 and 3. The remainder of this paper is organized as follows: section 2 is Hypothesis development, section 3 is Methodology, section 4 is Data, section 5 is Empirical results, and section 6 is Conclusion.

2 - HYPOTHESIS DEVELOPMENT

2.1 - THE OPTION TRADING STRATEGIES

The Covered call strategy is a combination of a long equity position and a short call option. The investor receives a premium from selling the option, and the long equity position covers the investor from the payoff on the short call. In contrast, the position would be naked if the investor only shorted the call without the long equity position (Hull, 2012). The strategy suits the investor that believes the underlying stock will move down or stay at the present price.

The Covered combination is similar to Covered call, but in addition to shorting a call you also short a put (Hemler and Miller, 2015). The investor then takes on additional risk with exposure to an additional option, potentially gaining more premium for selling two instead of one. This strategy is suitable if the investor thinks that the underlying stock will make small movements going forward, preferably none at all.

The Protective put is a strategy that is typically used to reduce the risk of the underlying asset. The strategy involves buying a put option on a stock and the stock itself (Hull, 2012). This strategy would be chosen if the investor believes that the asset would decline in value. The investor would then be protected as the long put option hedges the position from a large downward move. However, reducing this risk requires a payment of the options premium, which will reduce potential profits.

The Straddle, or more specific: *top straddle or straddle write*, is created by selling a call and a put with the same exercise price and expiration date (Hull, 2012). This strategy is appropriate if the investor think the stock will be close to the strike price at maturity.

The Strangle, or more specific: *top vertical combination*, is similar to the straddle but with different strike prices. It can be appropriate for an investor who feels that large stock price moves are unlikely (Hull, 2012).

The Butterfly Spread involves positions in options with 3 different strike prices. Buy a European call option with a relatively low strike price, K1, short 2 call options with strike price close to the current stock price, K2, buy a call option with a relatively high strike price, K3.

(Hull, p.242, 2012). It is appropriate for an investor who feels that large stock price moves are unlikely (Hull, 2012).

For additional information about the strategies we refer to Options, Futures, and other Derivatives by Hull (2012).

2.2 - Theoretical foundation

There are numerous studies analyzing the use of options in the American stock market. For example Hemler and Miller (2015), who use the S&P500 and individual stocks for their options strategies. The individual stocks are the 10 most commonly used stocks in 401(k)s, which is a pension account for the American citizens. We have a slightly different approach as we wanted to use the 10 largest stocks on the OSE. Hemler and Miller (2015) examine monthly returns from 5 strategies that include a mixture of long stock and option strategies. The article finds evidence that some option strategies with a long equity position, Covered combination and Covered call, outperform the long stock strategy in the American market. We would like to see if this can be transferred to the Norwegian market, using data from the OSE. Another popular strategy tested in the same article, the Protective put, will also be included.

The Covered call seems to be one of the most popular option strategies. There are several articles that covers the topic, and most of them find that the strategy outperforms the benchmark, buy and hold, on a risk-adjusted basis; see Kapadia and Szado's (2007) and Hemler and Miller (2015). Kapadia and Szado's (2007) compare a buy-write strategy on the Russell 2000 index with a buy and hold of the same index. Their findings are that the volatility often is lower for the buy-write than the buy and hold, and that the strategy consistently outperforms the index on a risk-adjusted basis. A similar article that addresses Covered call is Board, Sutcliffe and Patrinos (2010). They compare the performance of the buy-write strategy with a simple buy and hold of the index. They conclude that writing Covered calls is a beneficial strategy and point out that the variance of the returns are lower.

Hemler and Miller (2015) look at different types of option strategies and compare them to a long equity position. They find that both Covered call and Covered combination are strategies that outperform the long equity positions, and that the combination can be helpful in improving the risk-return characteristics of a long equity portfolio.

Hemler and Miller (2015) examine the Covered combination strategy and on a risk-adjusted basis find that this strategy outperform the other 4. It ranked highest across all 4 performance measures: Sharpe ratio, Jensen's alpha, Treynor Ratio and Sortino ratio, and had the best average ranking regardless of the time period considered.

Out of the 4 option strategies Hemler and Miller (2015) test, the Protective put is the strategy with the lowest risk-adjusted returns. They address the problem of determining optimal portfolios that may include options to maximize returns with limited risk relative to buy and hold strategy. The paper confirms our thoughts on the protective put strategy, that it is reducing risk, but at the cost of potential profits.

In addition to Protective put, Covered call, and Covered combination several other strategies are popular among traders. According to Chaput and Ederington (2005) the most popular trades among Eurodollar option traders are Straddles and Strangles. From the same article we find that implied volatility is an important aspect of trading options. Ederington and Guan (2002) and Kapadia and Szado (2007) claim that the implied volatility makes the trades consistently profitable when shorting high implied volatility trades in the S&P 500 options market. Whaley (2002) and Bakshi and Kapadia (2003) find that the implied volatility tends to consistently exceed actual volatility, so that a strategy of shorting volatility tends to be profitable. Because of the popularity of the strategies, we wanted to include these in our analysis together with the Covered call, Covered combination and Protective put. The aspect of volatility will also be included, because it is frequently mentioned in several of the articles above.

The strategies are to be tested in the Norwegian stock market, stocks and options from Oslo Stock Exchange. One possible challenge with these trades (Straddles/Strangles) is that they are not risk-defined the same way a Butterfly Spread would be. Therefore, we want to include this trading strategy too. Butterfly Spread is basically the same as the 2 aforementioned Straddle and Strangle, but the downside is limited, which is likely to make them more attractive to risk-averse traders and investors.

One of the most important concepts in finance is diversification. There are numerous articles that covers this topic in addition to Bodie, Kane, Marcus (2014). The OBX-index includes the 25 largest companies listed on Oslo Stock Exchange, which makes this index well diversified. However, in this thesis we are testing whether these strategies beats the simple buy and hold using both single stock and the OBX index. It is worth mentioning that using single stocks implicitly mean that the investor takes on extra firm-specific risk, which might affect the results (Bodie, Kane, Marcus 2014).

The 3 last strategies will generate most income if the underlying stock or index keeps within a certain range at expiration. Kapadia and Szado's article from 2007 argues that the time to maturity should be 1 month, as this tends to be the most profitable timeframe. We will therefore use options with a time to maturity as close to 1 month as possible, for all our options strategies.

In theory options are priced commensurate with risk. Adding an option to a portfolio should only increase the expected returns if it increases the risk of the portfolio. Similarly, reducing the risk of the portfolio comes at a cost (the price of the option) that will reduce expected returns. However, empirical research has showed that adding options to portfolios or option portfolios has increased risk-return relations in other studies. We now want to investigate this on the OSE, because options are becoming more popular on the said stock exchange.

2.4 - HYPOTHESES

Based on the articles written by Hemler and Miller (2015), Kapadia and Szado's (2007), Board, Sutcliffe and Patrinos (2010), Chaput and Ederington (2005), Ederington and Guan (2002), Whaley (2002) and Bakshi and Kapadia (2003) these are our *hypotheses*:

Hypothesis 1: *Are Hemler and Miller's results transferrable to the Norwegian market? Do the Protective put, Covered call and Covered combination outperform the simple buy-and-hold strategy?*

Hypothesis 2: *Do the short Straddle and Strangle generate consistent profitable trades when using implied volatility as a trading signal?*

Hypothesis 3: *How does the results from hypothesis 2 change when we use an option strategy with limited downside?*

2.3 - What do we expect to find

Hypothesis 1:

Hemler and Miller (2015) find that the risk associated with a given strategy, such as Covered call, often had lower standard deviation and higher mean of returns than its corresponding stock. The 5 individual stocks all had higher mean returns over the entire period and over each sub period. The Sharpe ratios are also higher than its corresponding long equity strategy (Hemler and Miller, 2015). Therefore, we expect to find some improvements on these measurements as well. The covered call and covered combination is expected to beat the simple buy and hold of the stock, and conversely, the protective put will be outperformed by the long stock strategy. Table 1-3 give our performance measure results for the strategies under hypothesis 1.

Hypothesis 2:

As these strategies are more popular among traders, which is the initial reason for including the strategies in the first place, our thoughts are that these strategies will outperform the previous 4. Especially when including the signal of implied volatility as a trading rule, according to Ederington and Guan (2002). Kapadia and Szado (2007) stated that the implied volatility could help the strategies in becoming consistently profitable. We therefore expect that these strategies will be among the top performers across all measures with the use of implied volatility. Table 4-7 give our performance measure results for the strategies under hypothesis 2.

Hypothesis 3:

As strategies with limited downside obviously adds an additional cost, as investors need to buy the extra options to hedge against extreme events, we expect that the Butterfly spread will perform slightly worse than, but quite similar to, the Straddle. Based on the Ederington and Guan (2002) and Kapadia and Szado (2007) we are expecting the use of implied volatility will improve the profitability of the strategies. We will first be presenting the results from the Butterfly spread with the use of implied volatility as a signal for a trading rule. Then we will be presenting the strategy without the use of the implied volatility, as we consistently short the strategy with a minimum of 5 days between each position. Table 8-9 give our performance measure results for the strategies under hypothesis 3.

3 - METHODOLOGY

3.1 - HYPOTHESIS 1.

We want to examine the 7 strategies: Long stock, Covered combination, Covered call, Protective put, Straddle, Strangle and Butterfly spread for 10 stocks and the OBX. We will look at their performance from 2005-2015, both over the entire period and over the first and second halves separately, using 3 widely used measures: Sharpe ratio, Jensen's alpha, and Information ratio. The first 2 measures is also used by Hemler and Miller (2015) and therefore make our research question of transferable results easier to answer. We choose these measures partly because of the measures is used by Hemler and Miller (2015), but also as a result of Eckbo and Ødegård (2015). The article gives the reader a good understanding of the risk-adjusted measures, and why it is important to focus not merely on the returns but also incorporate the risk associated with the strategy. The first of our risk-adjusted performance measure is the Sharpe ratio. The ratio divides the portfolio's excess return by the standard deviation:

$$SR(r_p) = \frac{E(r_p^e)}{\sigma(r_p)} \qquad (1)$$

In equation 1:r_p^e is the excess return: $r_p - r_f$, $E(r_p^e)$ is the expected excess return, and $\sigma(r_p)$ is the standard deviation of the returns (r_p) (Eckbo og Ødegård, 2015).

The Sharpe Ratio is not without flaws, as it merely includes the standard deviation of returns as a measure of risk. The standard deviation of returns typically includes both diversifiable and not diversifiable risk. Not diversifiable risk is the risk in one or more priced risk factors, which gives rise to a expected return beyond the risk free rate of return. The diversifiable risk on the other hand is risk that can be eliminated by expanding the number of securities in the portfolio (Eckbo og Ødegård, 2015).

Jensen's alpha is the constant in a linear regression where the appropriate market return is the benchmark.

$$r_p^e = \alpha + \beta r_m^e + \varepsilon_p \qquad (2)$$

In equation 2:$r_m^e = r_m - r_f$, the market index excess returns, α is the constant (the part of average r_p^e that cannot be explained by variations in r_m^e), β is the regression slope, and ε_p is a error term with expected value of zero, and without covariance with r_m (Eckbo og Ødegård, 2015, p.353). The statistical definition of the constant, Alpha, is that it is the part of the portfolios average return that cannot be explained by the sum of the risk premium that is harvested by exposing your portfolio to the risk factor (Eckbo og Ødegård, 2015, p.354). A positive (negative) Alpha in a regression model that contains the market index can be interpreted that the investment manager has "beaten" (or underperformed) the stock market/benchmark (Eckbo og Ødegård, 2015, p.354).

The last of our risk-adjusted measures is the Information ratio, which is based on both the Sharpe ratio and the Alpha intuition. The Information ratio is defined relative to a reference index.

$$IR_p = \frac{\alpha_p}{\sigma(e_p)} \qquad (3)$$

In equation 3: α_p is the portfolios Alpha. The denominator, $\sigma(e_p)$, is the standard deviation of the excess return, also known as "tracking error". The important aspect is that IR scales down the Alpha with the diversifiable risk. The Alpha is "punished" as a result of the diversifiable risk the investment manager takes (Eckbo og Ødegård, 2015, p.356).

All of our options-based strategies involve the choice of one or more options. For the first strategies, included in Hypothesis 1, we chose call and put options that are at least 5% out of the money with a time to maturity of approximately 1 month. 5 % is the same percentage as Hemler and Miller (2015), making it easy to compare our results with theirs.

We will backtest our strategies using codes written in the program R, and combine a long stock position in the stock or index with short and long positions in options. The codes simply finds the appropriate options and makes sure that the portfolio does not buy or sell options before the previous shorted (*or long*) options have expired. For example, if the first long put option in the protective put strategy expires 21st of June, we will only be able to buy a new put option after this date. When the appropriate options are selected, we need to merge them with the stocks development. We argue that the most appropriate approach is to use the first observed unadjusted stock price for each given timeframe (first, last, or all 10 years), and then reinvest the received premium in the stock. This is of course difficult to apply in practice, as premiums are less than the stock price at that given date, and not to mention the transaction costs. The payoff is also simply withdrawn (added) from (to) the strategy. The returns of the underlying stock are calculated from the adjusted stock price.

To demonstrate the process we will use the Covered combination strategy as an example. The loop we have constructed will for any given date check if there are suitable options available. Suitable meaning that the option has a maturity between 27 and 33 days, which is equivalent to 1 month of maturity, and strike price between 5 and 10 % in either direction. It is also implemented a function that picks the best available option. If there are several alternatives, the function chooses the option that's closest to 5 %. The premiums are added to the strategy consecutively, and the opposite goes for the payoffs, as we are shorting options in Covered combination. As previously mentioned the development in the underlying stock is calculated using the adjusted stock price, and the start of the strategy is the unadjusted stock price. For OBX, the first 5 years, we use the unadjusted price from 30th of June 2005, NOK 953, add up the development using the approach defined above. The premium is received on the date we short the option, and the payoff is subtracted on the expiration date. See figure 1 for a graphical presentation of the Covered combination for the OBX. After the strategy is correctly summed up, we merge the risk free rate and benchmark, OSEBX. This is to get the exact number of days in the time series-objects and to be able to compare the observations with the correct corresponding observations. Lastly, the returns and the previously mentioned risk-adjusted measures are calculated and presented at the end of the codes.

3.2 - Hypothesis 2 and 3

Hemler and Miller (2015) describes in detail how we should go about testing the first of our hypotheses. In this section of our thesis, we will supply a detailed specification of our approach concerning hypotheses 2 and 3. As these 2 hypotheses are included to test the more popular strategies among traders, the method used is slightly different from Hemler and Miller (2015). Nonetheless, the results will be presented in terms of risk-adjusted returns, making them comparable to hypothesis 1. As previously mentioned we use the 3 standard performance measures: Sharpe ratio, Jensens alpha, and Information ratio to compare the different strategies.

The trading signal: implied volatility

Hypothesis 2 and 3 include the use of implied volatility as a signal for which of the options we pick for the given week. Each of the 3 trading-strategies we test will short high volatility options with a minimum of 5 days between the positions. We use a simple mathematical approach to determine whether the implied volatility is high or low. With our historical option prices, we can easily calculate the historical implied volatilities for a given period. Then we provide descriptive statistics together with a chart of the implied volatility for comparable options. With comparable options, we mean that the options must have identical variables such as time to maturity, strike price and underlying asset. By calculating these measures for our given sample of 10 years, we see when the implied volatility is high, and when it is low. When the implied volatility is higher than its simple moving average, we will be able to short that given option, and conversely, when it is lower, we will not. The use of implied volatility can help our trading strategies become more profitable, as the articles presented in the hypothesis development section claims, and for comparison we will add the strategies without the implied volatility. High implied volatility should enlarge the premiums we receive, as higher implied volatility generally equals higher premiums.

THE OPTION-STRATEGIES: STRADDLE, STRANGLE, AND BUTTERFLY SPREAD

We have also chosen the more popular trades Straddle and Strangle to test whether a more trader-based approach can outperform the simple buy and hold strategy. The butterfly spread is included as it is risk-defined, meaning that you have a limit to your loss if the underlying should make an adverse move in either direction. This is a feature that might be highly valuable to certain risk-averse investors. Payoff calculations for all our strategies are included in table 1 to 10.

There are challenges regarding the choice of options relating to these strategies. Single stocks may be more volatile than the OBX, and new information about a single company, and/or the industry, may cause adverse movements in the stockprice. This can obviously make the options expire in our disfavor. Nonetheless, we will replicate Hemler and Miller (2015) and go for options that are at least 5% out of the money for both Strangle and Butterfly Spread. This would also make the strategies more comparable with hypothesis 1. Note that in practice you may want to account for companies' earnings report as this can make the stock more volatile in the coming period. For example, if a company is planning to release a report on earnings the following day, you may want to wait setting up a short straddle as this information may cause the stock to make adverse movements in either direction. We want to know if these option strategies, with the help of implied volatility, generate consistent profitable trades. We do not include earning reports in our analysis, as our thesis does not seek to cope with this issue, but merely wanting to highlight the potential trouble related to including individual stocks in the sample. We seek to simply use implied volatility and test whether this indicator could help our trades become profitable. The strategies are adjusted for both stock splits and reverse stock splits, and the start of the strategies equals the unadjusted stock price of the first observable date in the chosen timeframe.

Straddle, example:

We illustrated the process of setting up a Covered combination has been illustrated in the section discussing the methodology of hypothesis 1. Since hypothesis 2 and 3 are including the indicator implied volatility, we reckon that an example should be provided to illustrate this procedure as well. As mentioned in the section above, the options should be at least 5 % out of the money. This applies to short Strangle and Butterfly Spread. However, short Straddle does not use options out of the money, but at the money options, meaning that the options should be as close to the present stock price as possible.

The last period, counting 5 years forward from 30th of June 2010 was chosen to illustrate the short Straddle, and the company of choice is Statoil. Similar to the strategies under hypothesis 1 the start of the strategy will be the unadjusted price for that given date, 30th of June, which in this case is NOK 126. As this is a Straddle, we need to extract the options that are closest to the stock price at that given date. Out backtesting codes extracts the options ranging from 2 % below to 2 % over the given price, and similar to the other strategies only extracts options that has a day-count of 27 to 33 days. A function then chooses the best available, which is the option with a strike price closest to the stock price. After the correct options have been extracted from the original options data frame, we merge these with the date of the adjusted stock, so that we get the development for the appropriate periods. Premiums and payoffs are sorted by different dates, as premiums need to be placed at the date of the option, the date we short the option, and payoffs need to be placed at the expiration date. For the chosen Straddle, the premiums are added, as they are short positions, and payoffs are subtracted. After adding all the premiums and payoffs at the appropriate dates and converting the data frames to time series objects, the risk-adjusted returns are being calculated and presented.

The section above describes the strategy Straddle without the use of implied volatility. To check whether this indicator can help improve the risk-adjusted measures of the strategy, we decided to calculate the implied volatility of all the call options, and then add a simple moving average (SMA) to decide when the implied volatility is high or low. This is graphically presented in figure 5. The calculation of implied volatility are conducted using the package fOptions and the name of the function is GBSVolatility. This option-valuation package in R uses the Black-Scholes option pricing model, and provides us with the implied volatility of the option. We use a SMA with number of observations equal to 4, which means that the 4 last observations are being used for calculating the average. When the SMA of the implied volatility is above the implied volatility for any given option, we do not short it, but wait until the implied volatility is above the SMA. The implied volatility is then higher than its calculated mean, which according to the aforementioned articles could help improve the performance of the strategy.

The Strangle is similar to the Straddle, but the strike prices should be 5 % out of the money on either end, resulting in a wider spread.

The Butterfly spread, on the other hand, are not identical to any of the aforementioned option strategies, so we find that an example is appropriate to illustrate the approach being used in hypothesis 3. To illustrate this strategy we will use a more detailed approach. We use options on DNB dated 16^{th} of May 2011. Time to maturity equals 1 month. The Butterfly Spread, similar to the short Straddle and Strangle, will trade based on the level of implied volatility. For the Butterfly Spread we use the at-the-money options to calculate the implied volatility, and the implied volatility for the option contract is approximately 19.79 %. Similar to H2 we will short this given option if the implied volatility is higher than the SMA over the last 4 observations, which it is, as the SMA on that given date are 17.66 %. The stock price on the 16^{th} of May is NOK 80,05. The correct options are found by sorting the options and picking the one closest to our desired percentages. We will, simultaneously, short 2 times the number of long contracts on either end, with at-the-money options, which will lead to a successful set up of our previously described Butterfly Spread. For this given date the end result of the price was 6.18%, -0.06%, and -6.31% away from the present stock price, for the out of the money call, at the money calls, and in the money call, respectively.

3.3 - EARLY EXERCISE

Zivney (1991) uses prices from the Chicago Board Options Exchange (CBOE), more precisely S&P 100 index options, to determine the market value of early exercise. They examine the value of early exercise by looking at the difference in prices between an American option and an otherwise identical European option. They find that the value of early exercise for put options is greater than for call options, which is contrary to several recent papers that indicate that the value of early exercise is quite small. Barraclough and Whaley (2012) wrote a similar article, and the purpose of their study is to develop an understanding of the exercise behavior of put option holders in U.S. stock option markets. The paper finds that while a number of studies have examined early exercise decisions of call option holders, the early exercise behavior of put option holders has gone largely unexplored. The reason is that the decision to exercise a put option early is more complicated than it is for a call option. They find that millions of put options contracts remain unexercised on days when they should be exercised. The purpose of these articles is to highlight that there are some benefits of early exercise, however, they are not significantly large, and based on these articles and for simplicity, we will not include early exercise in our study.

3.4 - R-CODE

The codes written in this thesis was more comprehensive than first anticipated, and during this semester vast amount of time have been spent in the program R. The process have been enormously educational and writing the codes have been an eye-opener in terms of what these tools are capable of. The codes have been written separately to solve the different challenges related to each strategy. There are 15 R Scripts counting approximately 8500 lines of codes, each Script are using several packages, some up to 11. With a mixture of loops, if-sentences, and functions, R has solved our problems and made backtesting these strategies pretty easy. These codes also evolved into quite time-consuming processes. Therefore, we found it necessary to implement the use of parallel programming. This dramatically shortened the time we needed to wait for the computer to present the results. To fully comprehend the amount of work put into R during this semester you need to look at the codes themselves, which of course are available upon request. Nevertheless, below you will find a more or less detailed description of how the codes work.

To illustrate how the codes work we will use 2 examples together with a short paragraph explaining the automation of the Scripts. Example 1: Covered Call, and example 2: Butterfly Spread with the use of implied volatility as a trading signal.

To backtest a Covered Call strategy with the non-automated Script we need to state which of the companies we want to test the strategy on, together with the appropriate time to maturity and thresholds for the strike price. We also need to tell R which period it is to backtest for, the first 5, last 5, or all 10 years. More specifically we need to tell R precisely how many days the time to maturity can be, from 27 to 33 days, or only 30. The same applies for the strike price thresholds. We need to state precisely between which percentages we want to include or exclude an option for any given strategy. For every strategy we ended up with 5 percent as the lower level and 10 percent as the upper level. This goes both ways, meaning that for any put options the appropriate percentages are minus 5 percent and minus 10 percent. We also needed a function that would pick the best available option if there are several options that matched our criteria. The function was written and implemented, and would choose the option closest to 5 percent for the given example. After we have supplied R with the information it requires to present the results, we run the entire Script, and the program sort out the appropriate options. For the Covered call, Covered combination, and Protective put we coded that R could not sell, or buy, options as long as the previous sold, or bought, option had yet to expire. For the first observable date after the previous option have expired, the Script finds the relevant option, with the appropriate time to maturity and strike price, and short the option for the Covered call strategy. This continues throughout the entire time frame chosen to backtest. After correcting for small disputes such as stock splits and reverse stock splits, the codes merge the appropriate options with the development of the underlying stock. It calculates the returns from the adjusted price, and the strategy starts at the level of the unadjusted stock price. The long stock strategy is calculated the same way, but obviously without including the options, making the 2 of them comparable. With the development of the strategy in place, the next step was to calculate the returns of the aforementioned, to be able to calculate the risk-adjusted performance measures. After calculating returns, all the required data frames, namely the risk-free rate of return, the benchmark index: OSEBX, the long stock, and the option strategy, are merged to match the dates of each other. This is obviously to be able to compare the returns for a given day with the correct corresponding return for any of the 4 mentioned. After the returns are sorted, the data frames are converted into extended time series objects (xts), making them very applicable to charts in R and analysis in general. The risk-adjusted measures is calculated as explained in the methodology section and presented together with a chart with both the long stock and the corresponding Covered Call strategy.

Even though there are similarities in the codes for the Covered Call and the Butterfly Spread, the latter have a quite complex set up in terms of which options to choose and when to sell the strategy. To be able to backtest a Butterfly Spread you need all the aforementioned inputs, in addition to several others, such as the number of observations to include for calculating the simple moving average of the implied volatility. All of these adjustable inputs are on top of the Script, making it easy to adjust them before running the entire program. Including the implied volatility on the strategy or not, are simple as the user only need to set “V” or “X” in a field, telling the program whether to include the signal or not. For this strategy, as previously explained in the methodology section, we need options with 3 different strike prices: 1 in the money, 2 at-the-money, and 1 out of the money. The appropriate thresholds for the three is: -10 percent to -5 percent, -2 percent to 2 percent, and 5 percent to 10 percent, all adjustable at the top of the Script. Similar to the above mentioned, a function will choose the best available option and extract it. This means the option closest to -5 percent, 0 percent, and 5 percent, respectively. The codes extract the appropriate options and makes sure that there are at least 5 days between each time we short the strategy. Stock splits and reverse stock splits are of course also process by the codes. It basically multiplies the option premiums and option payoffs to adjust for the split or reverse split. After the codes have extracted the correct options by using a combination of if-sentences, loops, and functions, the implied volatility is calculated for all of the at-the-money options. This lays the foundation for our trading signal based on the said. The simple moving average is calculated based on the implied volatility for the mentioned options. For our example, the simple moving average is the average of the 4 last observations. Once you move 1 observation forward the simple moving average exchange the said 4 with the 4 latest, essentially *moving* the average forward. A function is written to tell us when the implied volatility of the at-the-money option is above the calculated moving average. If it is above, the strategy is shorted, if it is beneath, it is not. This is graphically presented in figure 5, please note the red dots which indicate the trades, meaning that this is where we short the 2 at-the-money options and buy additional 1 at each side. If the codes do not find the appropriate options for the strategy on the same date, the codes move 1 date forward. For some of the companies with few observations in the data sample, this was challenging as the total number of trades for a 5 year period ended up being quite low. To be able to merge the risk-free rate of return and the benchmark index with the development in the strategy, we needed to sum up all the payoffs and premiums for any given date. The mentioned 2 are obviously added to the correct date, namely the expiration date and the trade date, respectively. After the merge that assures us that the returns for a given date are compared with the corresponding correct returns, the data frames are converted into time series objects making the calculations related to the risk-adjusted measures easy. The risk-adjusted measures are then presented together with a graphical presentation of how the strategy performed with the implied volatility of the at-the-money options and the simple moving average in the same chart.

In addition to the aforementioned functionality, we ended up with automating the Scripts. Put simply, we gave R a list of company names and made it do a number of calculations for each company before returning the results in a row within a matrix. After the entire loop has finished, the matrix with the results is presented. Automating like this enabled us to focus on other tasks by making the computer do all the work. Even with the use of parallel programming, for some strategies the computer ran for a couple of hours before presenting the results. This illustrates the number of calculations needed to present the results and why automating the process was a necessity.

4 - DATA

The data sample is chosen based on the market size of the company and available options on TITLON. TITLON is the financial database we used to gather our data. The database contains daily data delivered from Oslo Stock Exchange.

Initially, we wanted the 10 largest stocks on the exchange. But due to lack of both option and stock data we did not end up with the mentioned ten, instead we had to settle with ten stocks that were amongst the largest on the exchange. We chose to also include the index OBX. The full sample is listed in table 15 together with descriptive statistics describing the stocks. All of the companies have 120 months of data except Gjensidige, who only got available data for the last 5 years. We have also attached histograms of the returns and added a curve on top indicating the appropriate normal distribution of returns see figure 3.

One example of an alteration we had to do with the data sample is that there are several observations where the premium, which is calculated as the average of the bid-ask spread, of the option is 0. This causes some problems to calculating the implied volatility and made us remove all of the options that had premiums equal to zero. Even if we used the zero-premium options in the trading strategy Protective put, which do not include the use of implied volatility, the results would be damaged as we would have bought free options and benefitted from them if the stock decreased below the strike price.

In general, the data sample has fewer option observations than we wished for. Some of the companies in the sample proved to have few options with the characteristics we wanted. The last five years is significantly better, but the first five years the number of options with the desired characteristics is quite few. The mentioned characteristics are for example for the Protective put: Put options that are between 5 to 10 % below the present stock price, and a day count of 27 to 33 days. This is exemplified in Figure 4.

Table 15 shows the descriptive evidence looking at the behavior of the underlying stocks and the index OBX. The statistics is based on the daily returns of the 10 stocks and the index. The statistics are presented for the full period of ten years in addition to two subperiods: all ten years (30th of June 2005 – 30th of June 2015), the first five years (30th of June 2005 – 30th of June 2010), and the last five years (30th of June 2010 – 30th of June 2015).

Table 15 includes the same measures as Hemler and Miller (2015) to compare the data samples. The statistics includes the mean, standard deviation, skewness, excess kurtosis, the Jarque-Bera statistic for testing the hypothesis that the return distribution is normal along with the corresponding p-values. Together with the mean of the returns and its standard deviation, we include the last 4 statistics for assessing the normality of returns, which affects the validity of regular portfolio performance measures.

The shape of a distribution is defined by the parameters, skewness and kurtosis. More importantly, for our data sample, when the distribution is negatively skewed the standard deviation will underestimate risk. Conversely, if the distribution is positively skewed, the standard deviation overestimates the risk because of extreme positive surprises and increase the estimate of volatility (Bodie, Kane, Marcus, 2014).

The average daily return of the index OBX is 0.03% over the full sample. The equivalent returns for the first and second subperiod is 0,02% and 0,05%, respectively. The large deviation can probably be explained by the financial crisis in 2007. For the individual stocks, average daily returns scale from -0,01% for Storebrand to 0,16% for Marine harvest over the entire sample. In the first subperiod, they range from -0,03% for Storebrand to 0,07% for Marine Harvest, and in the second subperiod they range from -0,02% for Subsea 7 to 0,24% for Marine Harvest.

When comparing each subperiod, we find that Subsea 7 is the only company that does not have an improvement in terms of daily average return, moving from the first subperiod to the second, leaving the rest with an improvement in the subperiod without the financial crisis. For the full period, Storebrand is the only company which have a negative average of returns with a measurement of -0,01%. Storebrand is also the only company which have a negative average return during the first subperiod. The average return is -0,03. The 2 worst performers in terms of average returns for the last subperiod are Subsea 7 and Storebrand, with average returns equal to -0,02 and -0,001, respectively. These 2 are the only two observations that are negative for this subperiod.

The Skewness of the index OBX is negatively skewed across all 3 periods. For the individual stocks, Marine Harvest stands out with positive skewness both over the entire period and each subperiod. For the first subperiod Orkla also has a positive skewness, but the remaining observations is negative.

The Jarque-Bera test is a test that controls if both the skewness and excess kurtosis is equal to 0, which would be the case if there is a normal distribution of returns. The null hypothesis of the test is a normal distribution, and the alternate hypothesis are a non-normal distribution.

The skewness and excess kurtosis statistics shows that there is little evidence for normal distribution across our data sample. The Jarque-Bera statistics with the associated p-values confirms that assumption. In all our observations, across all 3 periods, we get p-values less then 0,01. This is expected, also because of type 2 errors, as short time series increases the risk of rejecting the null hypothesis.

The index OSEBX is the main index at Oslo Stock Exchange. This index contains a selection of shares that together shall be representative of the listed companies on the Oslo Stock Exchange. The index is the most commonly used to measure the return on the Norwegian stock market. The index is adjusted every 6 months and downloaded from Oslo Børs (https://www.oslobors.no). The said index is the benchmark index we use when we calculate our risk-adjusted returns.

The risk-free rate of interest is an important concept in Derivatives pricing and finance in general. It is an important measurement that is critical when calculating the risk-adjusted returns, such as Sharpe. According to Derivatives by John C. Hull, the treasury bill are totally risk-free rates in the sense that an investor who buys a Treasury bill or Treasury bond is certain that interest and principal payments will be made as promised (Hull, 2012, p. 76) We calculated the risk-free rate of return using formula 4:

$$(1 + "3.month.T.bill")^{\frac{1}{360}} - 1 \qquad (4)$$

The Norwegian version of the 3 months treasury bill is the 3-months "statskasseveksel", which is downloaded from Norges Bank (norges-bank.no). There are some missing datapoints in the spreadsheet and we argue that the solution is to use the observation from the day before. For example, 17th of May 2013 the downloaded data sample did not have an observation and we therefore use the observation from the 16th of May as the risk-free rate of return.

According to TITLON, provider of our data sample, we have to use the unadjusted stock price, and not the adjusted, for backtesting our strategies. The reason is that the adjusted price will not match the strike price correctly as this is adjusted for stock splits and merges. Therefore, the correct stock price is the non-adjusted one. This is the case for the single stocks, and there are similar changes required for the OBX-index. After communicating with TITLON, we were informed that the index has to be multiplied by 4 from 21st of April 2006 and backwards, to account for the changes that happened on that same date. Several of the individual stocks also have splits and reverse splits. Norske Hydro, Orkla, and Marine Harvest all have splits and reverse splits that we have to account for in our analysis. For example: Norsk Hydro had 2 splits; a 5 for 1split at the 10th of May 2006 and a 3 for 1split at the 1st of October 2007. To deal with the splits, we simply multiply the number of options we short, so that an equal amount is shorted the entire period. If we did not account for this, the premiums received before the splits will be larger than the premiums received at the end of the period. The transaction costs would obviously go up in the mentioned example, as we need to short additional options, but we find this to be the most correct approach.

5 - EMPIRICAL RESULTS

In this part of the thesis we present and analyze our findings in terms of risk-adjusted returns.

5.1 - HYPOTHESIS 1:

"Are Hemler and Miller's results transferrable to the Norwegian market. Do the protective put, Covered call and Covered combination outperform the simple buy-and-hold?"

COVERED CALL

Table 1 Panel A shows our results for the Covered call strategy. For the full period of 10 years, we find that Marine Harvest got the highest Sharpe ratio of 0,0299. The second best is Telenor with a Sharpe of 0,0292, followed by the Index OBX, with 0,0185. There is only 1 of the Sharpe ratios that has a negative value, namely Storebrand, with a Sharpe of -0,0044. The second worst is Hydro, with 0,0038. Similar to the Sharpe results, the average mean only contains 1 negative value and the standard deviation of returns ranges from 0,0179 (OBX) to 0,0318 (Storebrand), Marine Harvest also gets the highest Jensen's alpha measure, with a value of 0,0007, then follows Telenor with 0,0004. Not surprisingly, Marine Harvest and Telenor are also awarded the highest Information ratios, with 0,026 and 0,0254, as IR reflects the Jensen's alpha but is "punished" for taking on diversifiable risk.

Table 1 Panel B show the results for the first subperiod. There is 4 out of the 11 that is negative in terms of Sharpe Ratio. Once more, Marine Harvest and Telenor is ranked highest, with a score of 0,0232 and 0,01947, respectively. Similarly, Storebrand is ranking last with a Sharpe of -0,0094. As for average return, Information ratio and Jensen's alpha, the same 2 ranks the highest. On the other hand, neither Marine Harvest nor Telenor does have the lowest standard deviation of returns.

Table 1 Panel C shows the results for the second subperiod. The order of the top performers has changed, but both Telenor and Marine Harvest is still ranking amongst the highest with Sharpe ratios of 0,0509 and 0,0453. The difference is the arrival of Gjensidige, who only contains data for the last 5 years. Gjensidige scored a Sharpe of 0,0812 and clearly outperforms the others in all of the risk-adjusted returns with an Alpha of 0,0008 and an IR of 0,0739. It has the second best standard deviation, only beaten by OBX. This also goes for the average return, where Gjensidige only is beaten by Marine Harvest. Generally, the results is better from the last 5 years of data. There is only 1 negative Sharpe ratio, namely Subsea 7 with a Sharpe of -0,0011, but several negative of the last 2 risk-adjusted measures. For a full overview, please find the appropriate measurements in Table 1.

COVERED COMBINATION

Table 2 Panel A shows the results for the Covered combination. For the full period of 10 years, the 2 best performers did not change from the Covered call, and Marine Harvest and Telenor, with Sharpe ratios of 0,0332 and 0,024, outperformed the others. This is also the case for both Jensen's alpha and IR. Storebrand is the worst performer in terms of all measures, including average return and standard deviation. Sharpe ratio is the absolute lowest with a measure of -0,006, followed by Subsea 7 with -0,00006. These are the only 2 negative Sharpe ratios, but several of the Alphas are negative, obviously making equally many of the IRs to be negative.

Table 2 Panel B shows the results for the first subperiod. Covered combination only has 3 stocks with positive Sharpe ratios, Alphas, and IRs, were the 2 best performers is Marine Harvest and Statoil, followed by Telenor. The Sharpes are 0,028, 0,012, and 0,01, respectively. The best performer, Marine Harvest, has Alpha and IR equal to 0,001 and 0,031. On the opposite side of the scale, we find Storebrand, the worst performer with a Sharpe of -0,014, and Alpha and IR of -0,0006 and -0,018, respectively.

Table 2 Panel C shows the results for the second subperiod. It solely includes positive Sharpe`s. This is not the case for Jensen's alpha nor IR, which both has 4 negative values, where the worst performer is Subsea 7 with a Sharpe of 0,0039. The highest Sharpe is Gjensidige 0,0845with Alpha and IR equal to 0,0009 and 0,077.

PROTECTIVE PUT

Table 3 Panel A shows the results for the Protective put. For the full period of 10 years, there is only 1 out of 11 which have a negative Sharpe ratio, namely Storebrand with a measure of -0,005. Jensen's alpha has 4 negative values, which also affects the IR and makes the same 4 negative. The highest measured Sharpe is Telenor with 0,0266, followed by OBX and Orkla, with 0,0236 and 0,0167, respectively.

Table 3 Panel B shows the results for the first subperiod. Subsea 7, OBX, and Telenor is the top performers, and their Sharpe ratios is 0,0199, 0,0197, and 0,0182, respectively. Both Statoil and Telenor, often among the top performers in Covered call and Covered combination, have negative measures in all of our performance measures. That includes the average return as well.

Table 3 Panel C shows the results for the second subperiod. Subsea 7 and Storebrand are the 2 worst performers in terms of all of our risk-adjusted measures, with Sharpe ratios of -0,0167 and -0,0067. The mentioned 2 are the only negative Sharpe ratios, leaving the rest positive. Ranging from Hydros Sharpe of 0,004, up to the best 2: Gjensidige and Telenor with Sharpes equal to 0,073 and 0,045, respectively. The Alpha measure has 5 positive values, where Gjensidige is the best performer with 0,0007, followed by Telenor and Orkla. For a full overview, please find the appropriate measurements in Table 3.

5.2 - HYPOTHESIS 2:

***"**Does shorting of the popular option strategies Straddle and Strangle generate consistent profitable trades when using implied volatility as a trading signal?"*

STRADDLE

Table 4 Panel A shows the results for the Straddle strategy with implied volatility as a signal for our trading rule. For the full period of 10 years, our first observation is that Yara are not included in the table. The strategy did not perform well enough, and the codes were therefore not able to calculate logarithmic returns as the strategy went below 0. For ease of reference this is graphically presented as Figure 2. Out of the other 9, as Gjensidige only have data for the last 5 years and are therefore not comparable, 3 has negative Sharpe ratios, whereas 2 of them, namely Telenor and Storebrand, also has negative Alphas and IRs. Storebrand is the worst performer in the remaining sample, with a negative average return, although small, together with all risk-adjusted measures being negative. At the positive side of the scale, Marine Harvest and Subsea 7 performed best with Sharpe ratios of 0,0159 and 0,0149, respectively. Jensen's alpha and IR for the top performer is 0,00045 and 0,0155.

Table 4 Panel B shows the results for the first subperiod. 2 out of the remaining sample of 9 has positive Sharpe ratios, leaving the rest negative. Yara did not make the table of results this time either, and the reason can be seen in Figure 2, showing the short Yara Straddle going below zero during the financial crisis. The best performers is Statoil and Marine Harvest with Sharpe Ratios of 0,0049 and 0,0016, respectively. Both of the aforementioned also has positive Alphas and IRs. Storebrand is the worst performer in this given timeframe for the straddle strategy, with a Sharpe of -0,02, in addition to negative Alpha and IR.

Table 4 Panel C shows the results for the second subperiod. The results are affected by the return of both Gjensidige and Yara, which ended up ranking as the best and worst performer measured in Sharpe ratio. Gjensidige outperformed all the others in terms of Sharpe ratio, whereas Yara is outperformed across all risk-adjusted measures by the other 10. Gjensidige has a Sharpe equal to 0,028, followed by Marine Harvest and Hydro, which has Sharpe ratios of 0,026 and 0,0248, respectively. Out of the 10 stocks, 3 has negative Sharpe ratios, whereas 2 of them also has negative Alpha and IR. For a full overview of the results, please find the attached Table 4.

STRADDLE WITHOUT IMPLIED VOLATILITY

To be able to answer hypothesis 2 we need to include the strategy without the use of implied volatility. This way we get to know how the strategy performs when shorting consecutively, with at least 5 days between each position, without any trading signal.

Table 5 Panel A shows the results for the Straddle strategy without the use of implied volatility. For the full period of 10 years, similar to the strategy with implied volatility, Yara is not included in the table, as the strategy performed poorly during the financial crisis which made calculations of the logarithmic returns impossible. In terms of Sharpe ratio, Statoil and Marine Harvest is the best performers with 0,0159 and 0,0128, respectively. There are 2 out of the 9 that is negative, and the only 1 that has negative Alpha and IR is the index OBX.

Table 5 Panel B shows the results for the first subperiod. They are once again affected by the financial crisis, and 4 out of the 9 are positive. Yara is again the worst performer, not even making it to the results table, as the calculations are impossible. The remaining 5 all have negative Sharpe, Alpha, and IR, whereas OBX and Subsea 7 is the worst performers. Their Sharpe ratio is -0,0169 and -0,0156, respectively. The best performers is Statoil and Marine Harvest, with Sharpe ratios equal to 0,0089 and 0,0068. The risk-adjusted measures are consistent in terms of which underlying stock performing good, in other words, the 4 that has positive Sharpe ratio also have positive Alpha and IR. Conversely, the remaining others has all negative risk-adjusted performance measures.

Table 5 Panel C shows the results for the second subperiod. Only 2 out of the full sample of 11 underlying stocks are negative in terms of Sharpe ratio, Jensen’s alpha, and Information Ratio, namely DNB and Yara. Yara performed good enough to be included in the results, but has the second worst performance of all, across all risk-adjusted measures. On the top of the table, we find Statoil and OBX, which have Sharpe ratios of 0,0286 and 0,0245, respectively.

STRANGLE

Similar to the Straddle strategy, we need the results with and without the use of implied volatility to able to answer the second hypothesis. Therefore, the strategy without the use of implied volatility as a signal is presented below.

Table 6 Panel A shows the results for the Strangle with the use of implied volatility as a signal. There are 4 positive Sharpe ratios, and 7 positive Alphas, making equally many IRs positive. Yara are not in the results table, as it did not perform good enough to be able to calculate the log returns. Marine Harvest is the best performer during the 10 year period with a Sharpe of 0,0227 followed by Subsea 7 and Statoil, with Sharpe ratios equal to 0,02 and 0,0177. The 2 worst performers for this given strategy are Storebrand and Hydro which has Sharpe ratios of -0,016 and -0,012, respectively.

Table 6 Panel B shows the results for the first subperiod. 6 out of 9 has negative Sharpe ratios. The best performer, Telenor, with the highest measuring Sharpe ratio, has negative Alpha and IR. Sharpe, Alpha, and IR is as follows 0,0174, -0,00015, and -0,0064, respectively. The worst performer in terms of Sharpe is Storebrand, followed by Hydro and OBX.

Table 6 Panel C shows the results for the second subperiod. There is 9 out of 11 that is positive in terms of Sharpe ratio. The 2 negative are also the only 2 negative Alphas and IRs. Orkla and Statoil both has Sharpe ratios of over 0,05, closely followed by Gjensidige and Subsea 7 with Sharpe ratios right below 0,05. Yara, once again, ranks as the worst performer across all the risk-adjusted performance measures, with all being negative.

STRANGLE WITHOUT IMPLIED VOLATILITY

Table 7 Panel A shows the results for the Strangle strategy without the use of implied volatility. The first observation, looking at the results for the full period of 10 years, is that Yara is not included in the table. However, the results without the use implied volatility as a signal have provided several more positive Sharpe ratios, compared to the strategy with the use of implied volatility. In total there are 7 out of 9 which are positive. The other 2 risk-adjusted measures, namely Jensen's alpha and Information Ratio, has both 8 out of 9 positive values. The best performers are Statoil and Marine Harvest with Sharpe ratios of 0,0323 and 0,0232. The index, OBX, performs the worst, with Sharpe, Alpha, and IR equal to -0,0026, -0,00004, and -0,0013, respectively.

Table 7 Panel B shows the results for the first subperiod. The first subperiod is affected by the financial crisis, and has 6 out of 9 negative Sharpe ratios. Yara does not perform well enough to be included in the table. The best performers is Statoil and DNB, closely followed by Marine Harvest. Their Sharpe ratios is 0,0244, 0,013, and 0,012, respectively. OBX is, once more, the worst performer in terms of all the risk-adjusted measures.

Table 7 Panel C shows the results for the second subperiod. 10 out of 11 are positive Sharpe ratios, Alphas, and IRs. The same underlying stock is responsible for all 3 of the negative risk-adjusted measures, namely DNB. DNB has Sharpe, Alpha, and IR equal to -0,0037, -0,00003, and -0,002, respectively. The top 3 performers, measured in Sharpe are Marine Harvest, Subsea 7, and Statoil. The same 3 also has the best Alphas and information ratios, in the exact same order. The mentioned 3 all has Sharpe ratios of over 0,06. It is also worth mentioning that Yara are positive across all risk-adjusted measures for this given time frame.

5.3 - Hypothesis 3:

"How does the results from hypothesis 2 change when we use an option strategy with limited downside?"

Butterfly Spread

Table 8 Panel A shows the results for the Butterfly Spread strategy with the use of implied volatility. For the full period of 10 years, there is only 1 positive Sharpe ratio, which is for the underlying index OBX. The worst performer, measured in Sharpe ratio, is Storebrand with -0,0347. 6 of each of the remaining risk-adjusted measures, Jensen's alpha and Information ratio, are negative. Yara, which often have been absent from the table of results, did not miss out here. However, Yara did end up with all of the risk-adjusted measures being negative.

Table 8 Panel B shows the results for the first subperiod. Not one of the Butterfly spreads resulted in positive Sharpe ratios. Several Alphas and IRs are positive, but a quick glance at the results table reveals that the strategy are among the worst performers overall. The 2 worst performers in terms of Sharpe ratio is Subsea 7 and Hydro, with -0,171 and -0,037, respectively. On top of the results table, we find Orkla and DNB, both with negative Sharpe, but positive Alpha and IR.

Table 8 Panel C shows the results for the second subperiod. Even though the risk-adjusted measures have improved some, only 2 out of the 11 Sharpe ratios are positive. Hydro and OBX is the only 2 positive ratios with values of 0,012 and 0,008, respectively. On the lower end of the table, we find Storebrand and DNB, where Storebrand performed the worst with all 3 risk-adjusted measures being negative, and a Sharpe equal to -0,075.

BUTTERFLY SPREAD WITHOUT IMPLIED VOLATILITY

Table 9 Panel A shows the results for the Butterfly Spread without the use of implied volatility as a signal for our trading rule. For the entire period of 10 years, every Sharpe ratio across the sample is negative. For the remaining 2 risk-adjusted measures, 6 out of 8 are negative. Both Marine Harvest and Yara performs too bad to be included in the results table, which leaves us with 8 risk-adjusted numbers left to analyze. The best performers, OBX and Storebrand, each with negative Sharpe ratio, both have positive Alpha and IR. On the other side of the table, we find Subsea 7 and DNB with Sharpe ratios equal to -0,032 and -0,02, respectively.

Table 9 Panel B shows the results for the first subperiod. Both Marine Harvest and Yara are back in the table. Marine Harvest actually resulted in being positive across all of the risk-adjusted measures. The same does not apply for Yara, which conversely ended up with every one of the risk-adjusted returns being negative. In total, there are 9 out of 10 which has negative Sharpe ratio. The equivalent number for both Jensen's alpha and Information ratio is 8. Subsea 7 performed the worst with a Sharpe ratio equal to -0,04, and Jensen's alpha and IR being negative as well.

Table 9 Panel C shows the results for the second subperiod. 2 out of 11 are positive Sharpe ratios. The 2 best performers are Storebrand and OBX, with all risk-adjusted returns being positive and Sharpe ratios of 0,0086 and 0,0062, respectively. There is 3 positive Alphas, and the same is true for the IR. Gjensidige performs the worst, with Sharpe ratio equal to -0,032 in addition to the remaining 2 risk-adjusted returns also being negative. Again, for a full overview of the results look at Table 9.

CONCLUDING REMARKS

To provide a full overview of the results, we have calculated the average of the 3 different risk-adjusted measures and included them in the Table 11, Panel A, B, and C. The simple calculation provides a good overview of which of the strategies has performed the best considering all the underlying stocks. The underlying stock should be considered if the investor chooses to implement some of the concepts explained in this thesis. Please find the appurtenant Tables: 12, 13, and 14 for a graphical overview of the performance of the individual stocks as well as the index OBX.

HYPOTHESIS 1:

Based on the results from the paragraphs above, we can determine whether the hypotheses should be rejected or not. Hypothesis 1 asks if the results from Hemler and Miller (2015) are transferable to the Norwegian stock market. Are the risk-adjusted measures and the characteristics of the strategies close to similar to the measures Hemler and Miller (2015) gets, or are they not? Our observation is that the results are not directly transferable, but we find some similarities. In terms of overall performance, the covered combination is a success for Hemler and Miller (2015). This does not hold true for our Covered combination. It is worth to mention the differences in our data samples. The time period, the different sample of stocks, and the markets themselves. Hemler and Miller (2015) may have more data than us, as they use the much larger American market, which implicitly means that they can be more persistent in executing the strategies. With persistent in executing the strategies we mean that more data can help our strategies trade more often during the time frame chosen. Also, the strike prices, if they were qouted in smaller increments, might help us stick to the preferred 5 %, and not include options ranging all the way up to 10% as a result of the lack of data. We argue that the options market in Norway are smaller than the corresponding market in the United States, making the number of available options fewer as there are fewer market participants and market makers. We think it is reasonable to assume that Hemler and Miller (2015) had more options to choose from, making backtesting of their strategies in the American market more consistent in terms of the strike prices and what percentages they are away from the present stock price. For our data sample, the first 5 years, the number of available options have been significantly fewer than the last 5. We also included the index OBX, whereas Hemler and Miller (2015) only use individual stocks. This is obviously variables and inputs that affect the results. It might also be fair to assume that the bid/ask spread in the American options market are smaller than for the less liquid Norwegian options market, understandably affecting the price of the options. Nonetheless, we thought that the results would be close to transferable, which is not the case, naming the Covered combination as an example. Covered call did however perform quite well and is actually the only strategy that beats the long equity position. Protective put ended up beating our expectations by far as it is ranked number 4 across all strategies, also including the Straddle, Strangle, and Butterfly spread, with and without the use of implied volatility. We therefore reject the first hypothesis. The results are not transferable to the Norwegian stock market.

Hypothesis 2:

Several of the reasons for differences between the 2 markets and data samples have been highlighted in the paragraph above. Nonetheless, we expect that the most popular trades, Strangle and Straddle, will perform quite well compared to the more simple long stock, Covered call, Covered combination, and Protective put. Especially when using the implied volatility as a signal for when to trade the options. This is obviously, according to the risk-adjusted returns, not the case. In terms of average Sharpe ratios for the entire sample of results, both of Straddle and Strangle, with and without the use of implied volatility, is outperformed by some of the strategies from hypothesis 1, namely Covered call and Long stock. Strangle, without the use of implied volatility as a trading signal, performed best out of the strategies under hypothesis 2, ranked number 3 of the total of 10 strategies. The remaining 3, ranked number 6, 7, and 8, is positioned behind the worst performer from the first hypothesis, Covered combination. Nonetheless, the hypothesis asks if the option strategies generate consistent profitable trades when using implied volatility as a trading signal. For a selection of the stocks the results are quite good, but this can obviously be said about the more simple approach buy and hold as well, which is included in the results table as Long stock. The strategies have some characteristics that some investors might find appealing to include in their portfolio. The 4 best Alpha measures are all Strangle and Straddle, with and without the use of implied volatility, where the best 2 are Strangle and Straddle, both without implied volatility. Even though many of the Alphas got positive values, it is worth to mention that these risk-adjusted measures should all be considered when choosing which of the strategies to include for the individual investor. A more detailed description of the risk-adjusted measures is provided under the methodology section. Even though these strategies might be of interest for some investors, the strategies that included the trading rule based on the signal from the implied volatility did not beat the same strategy without the use of implied volatility. This means that we have to reject the hypothesis. Shorting of the popular option strategies Straddle and Strangle do not generate consistent profitable trades when using implied volatility as a trading signal. The investors are, according to our data sample, better off excluding the implied volatility and simply short the strategies consistently.

Hypothesis 3:

We thought that the Butterfly spread would perform close to the results from the Straddle strategy, but at the same time be outperformed by the said strategy as the Butterfly spread is more expensive to establish. Whereas the Straddle and Strangle have some positive aspects to them, as they get quite good results from the Jensen's alpha, Butterfly spread, with and without the use of implied volatility, did not have the same positive aspects. For the 10 year period, both of the Butterfly spread strategies are outperformed by all other strategies in terms of all the risk-adjusted measures, namely Sharpe ratio, Jensen's alpha, and Information ratio. However, the Butterfly spread that uses implied volatility as a trading signal has better Sharpe ratio, Jensen's alpha, and Information ratio than its similar strategy without the use of implied volatility. Even though all 6 of these are negative. The strategies that use the implied volatility as a signal are dependent on similar options to firstly calculate the implied volatility and then implement the simple moving average to determine which of the options have a relatively high implied volatility. This costs the strategies with implied volatility some trades, making some of the strategies trade very few times during the period. This is worth mentioning as both strategies does not result in positive risk-adjusted measures, only the one being slightly worse than the other. It is therefore possible that the strategy performs quite bad all over, which the risk-adjusted returns suggests. For this case, fewer trades may have resulted in better results than many trades. Our last hypothesis asked how the results changes when we use a strategy with a limited downside. The first comment when answering this hypothesis should be that all the risk-adjusted measures are negative. As this hypothesis is formulated as a question open for discussion, rather than a simple reject or not reject hypothesis, we are not able to simply reject the hypothesis. The answer is, nonetheless, quite clear as all the risk-adjusted measures are negative for the full period of 10 years. Butterfly spread is a strategy that given our data sample and time frame does not perform well at all. If the investor considers the time used to set up the strategy and includes the transactional costs, which is not implemented in the results, the conclusion is that Butterfly spread is too expensive in terms of both time and money to even consider.

6. CONCLUSION

The focus of this thesis is on different types of option strategies to potentially improve the performance of an investor's portfolio. We are using risk-adjusted returns, thoroughly discussed by Eckbo and Ødegård (2015), to comment the performance of each of the strategies. From a theoretical perspective, options should be priced so that using them should not necessarily improve the risk-return characteristics for a well diversified portfolio. However, empirical research has showed that it does. Is this the case in Norway also, is what we are testing.

In short, our findings are that the simplest strategies perform quite well in contrast to the more complex Butterfly spread, which means that the investor do not have to set up complex option strategies to benefit from the use of options. Covered call, measured in Sharpe ratio, is ranked the best strategy across all 10 years. Long stock performed second best, followed by Strangle without the use of implied volatility. Overall, we find that the implied volatility does not make any of the strategies significantly better using a simple moving average to determine when the implied volatility is high and when it is low. The use of strategies such as Strangle and Straddle might have several positive attributes to certain investors, as the Alpha are highest for these particular strategies. However, the signal made with implied volatility does not make the trades consistently profitable. The third hypothesis, which asked about the performance of the strategy Butterfly spread, end up doing much worse than anticipated, being the 2 worst performers for all 10 years for Sharpe ratio, Jensen's alpha, and Information ratio. We therefore end up rejecting all of the hypotheses, as the results from Hemler and Miller (2015) are not directly transferable to the Norwegian market, and the implied volatility do not make the trades consistently profitable. Very few of the option trading strategies perform better than the buy and hold strategy. This underlines the effectiveness of the buy and hold strategy, but also tells us that the strategies gets outperformed by the much simpler investment strategy, buy and hold, and are therefore not recommendable. However, some benefits from the different strategies do exists as we have shown through high Alpha measures for the Straddle and Strangle strategies, and the surprisingly good results for the Protective put.

We find that it is not sufficient to look at these performance measures alone, one needs to look at them together to be able to tell if the strategy has performed well. A positive Alpha by itself does not count for much if the Sharpe ratio is negative, which means that the strategy has been outperformed by the risk free rate of return. The IR punishes the investor for taking on diversifiable risk, which basically all of our strategies do, as we use individual stocks, apart from one index: the OBX. In terms of IR, the 4 best performers are, similar to Jensen's alpha, the Strangle and Straddle, with and without the use of implied volatility.

These derivatives are of course quite useful in terms of risk management, and in some cases as our thesis highlight, worthy to include in your portfolio to improve its profitability. For these option strategies, we suspect that some firms are more attractive than others, which clearly have not been the focus of this thesis, but might be subject to further research by others. We find it necessary to mention this as we have seen that several of the companies, for example Yara, have multiple times ended up performing quite bad, across several strategies.

With this thesis, we are extending the research performed by Hemler and Miller (2015) to the Norwegian market. We are also diligently using the article written by Eckbo and Ødegård (2015) to be able to measure how the different strategies have performed in terms of risk-adjusted returns. We have therefore contributed to Eckbo and Ødegård (2015) by investigating common trading strategies. We also contribute to Hemler and Miller (2015) by investigating a different market and a different time period. In addition we contribute by developing a new method for testing hypothesis 2 and 3.

We want to prompt the fact that derivatives can make you lose money, and any investors who read this thesis to be careful of how they use these financial instruments. We also find it necessary to urge the fact that transactional costs are not implemented, and that all these findings must therefore be seen as merely a guidance of how the strategies will perform. The results will of course be affected of which terms you get from your derivatives provider.

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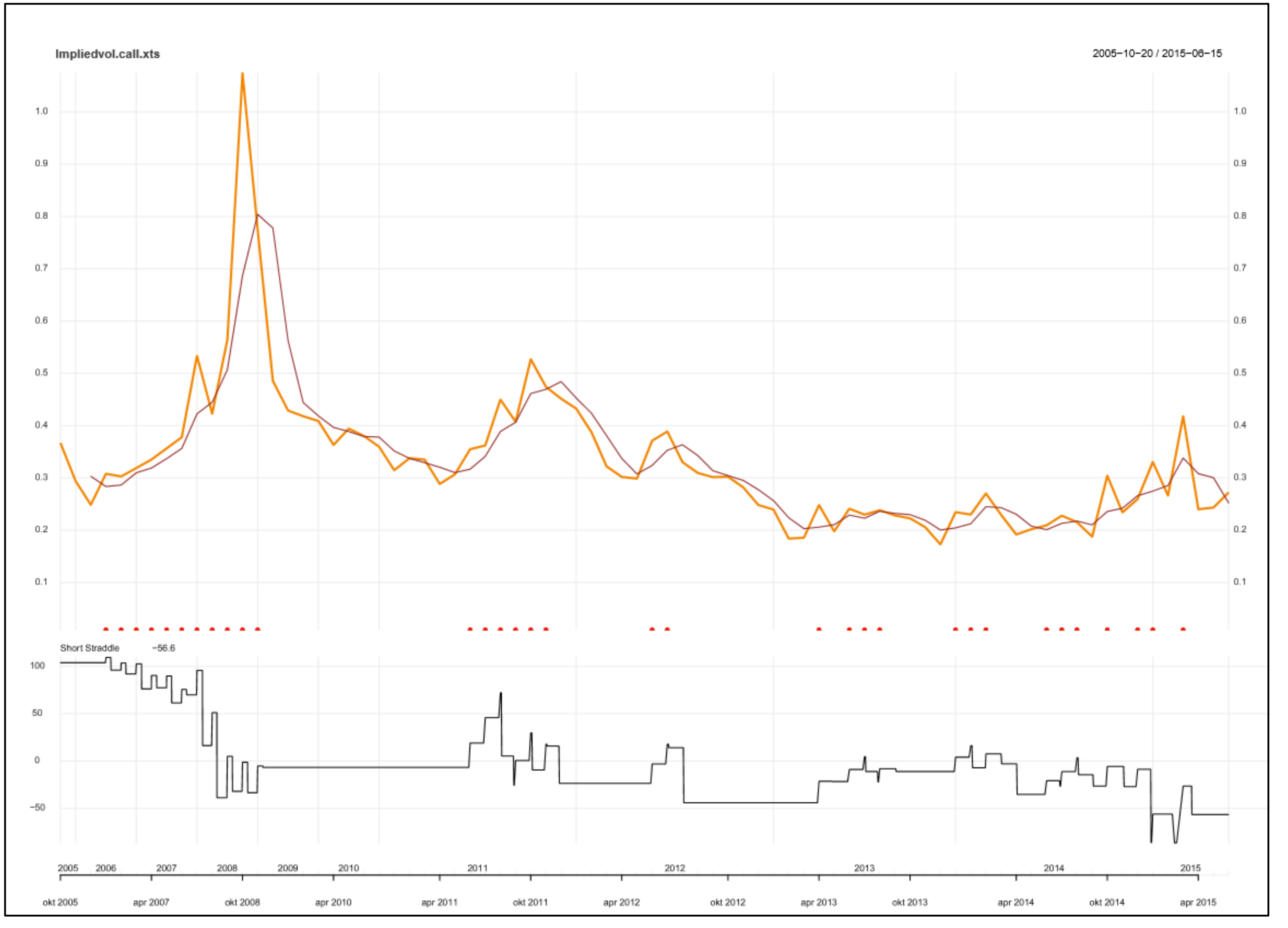
Figure 1: Covered combination, OBX

The graph illustrates the development of the Covered combination for the index OBX. The blue line represents the buy and hold. The red dots indicates where we have sold options.

Figure 2: Straddle, Yara with implied volatility



The figure above shows the Straddle trading strategy for the Yara stock, with the use of implied volatility as a signal. The appropriate simple moving average (red) are on top of the implied volatility (orange) The red dots indicates where we have sold options.

Figure 3.

Histograms of returns with normal curve.

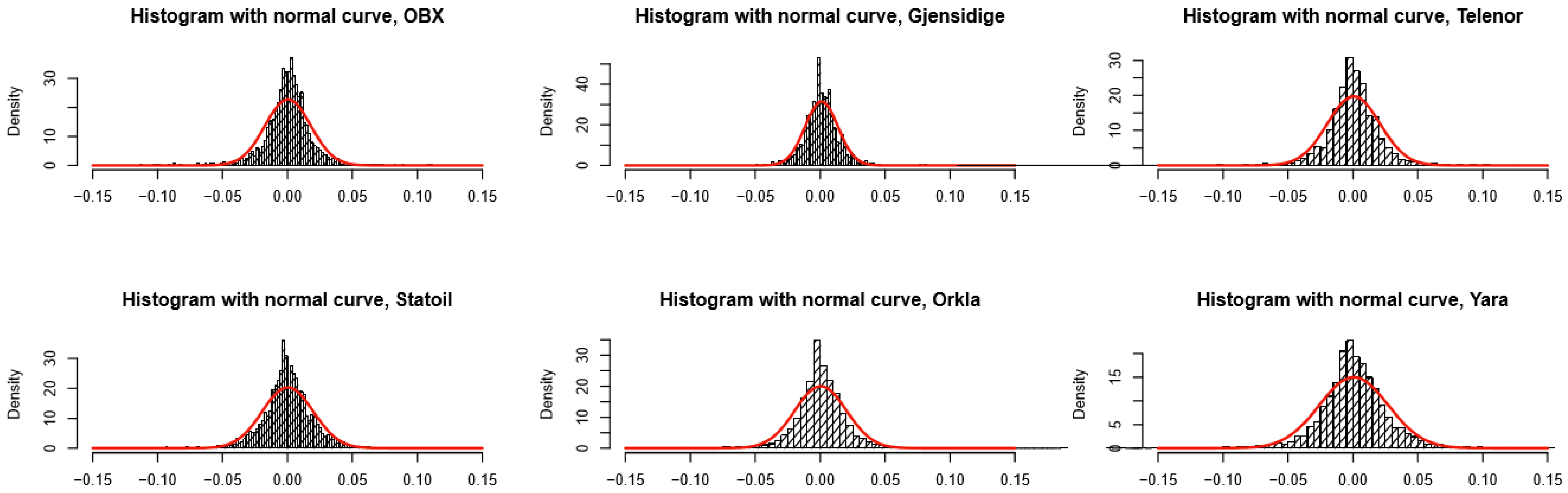


Figure 3 continues.

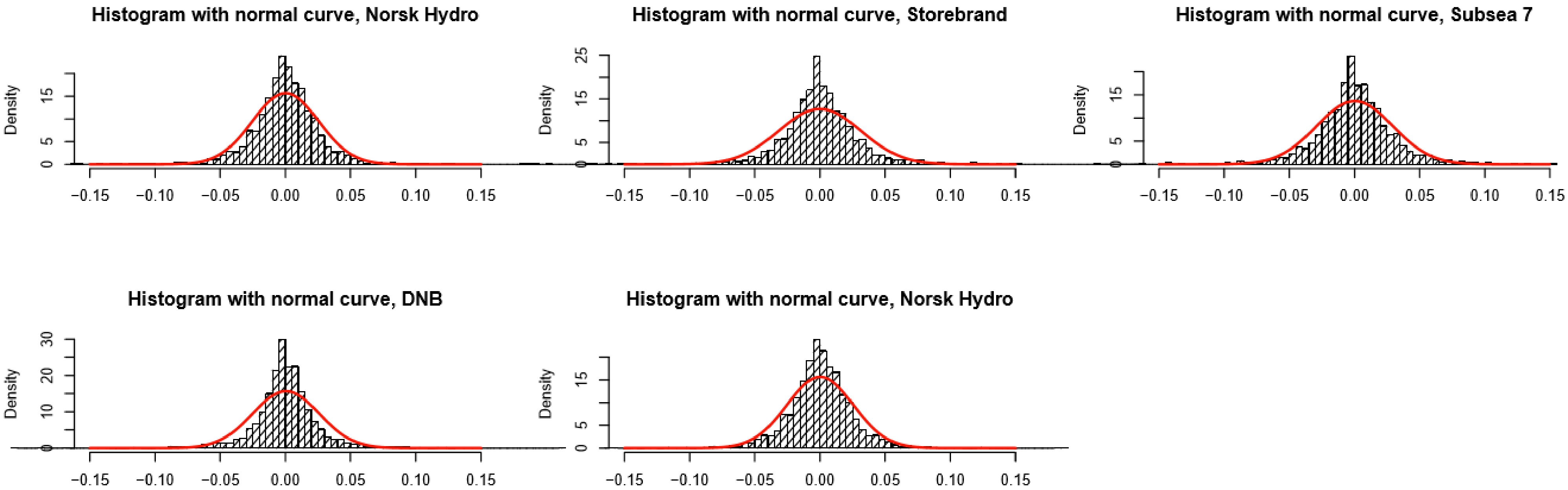
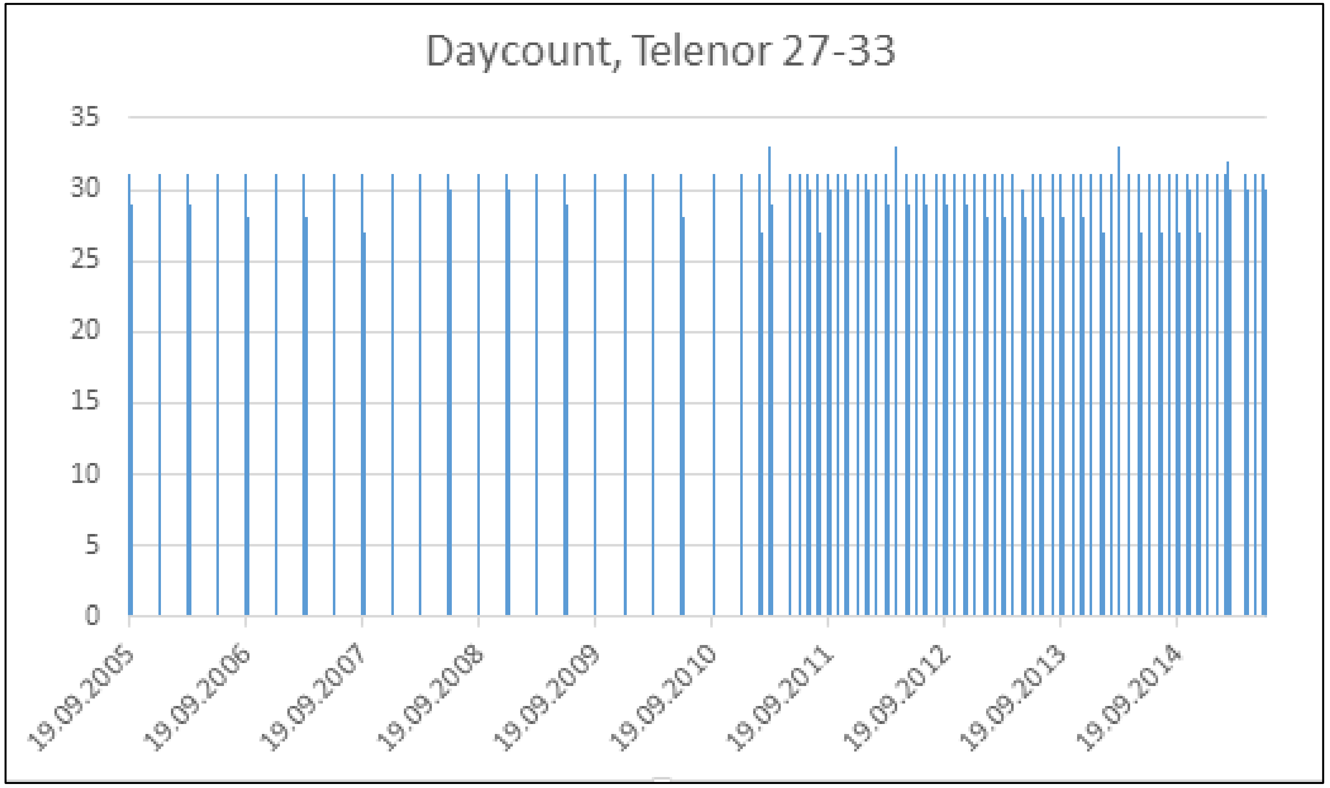
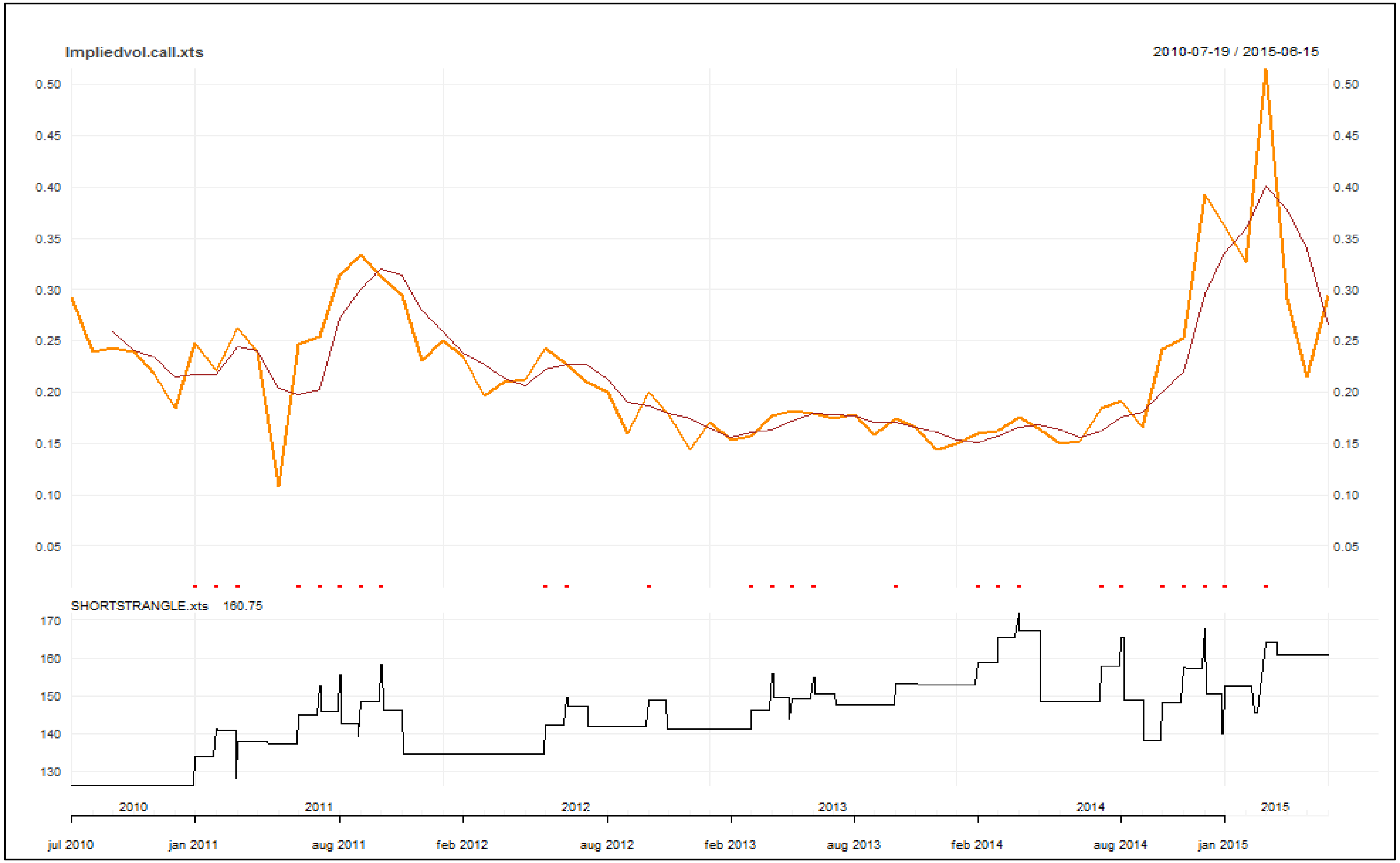


Figure 4



Most of the stocks have significantly fewer options available during the first 5 years, which this histogram illustrates. There are only options with daycount equal to 27-33 days included, similar to the options used in our strategies as preferred time to maturity equals 1 month.

Figure 5



The figure above illustrates the technique for the strategy short strangle, with the use of implied volatility and the appropriate simple moving average on top (red line equals SMA). The red dots indicate where we have sold options.

Table 1: Covered Call

The Tables shows Covered Call for all 10 years, first 5 years, and the last 5 years. The 3 performance measure are Sharpe Ratio, Jensen`s Alpha, and Information ratio.

Panel A

All 10	Sharpe	Jensen's alpha	IR
Orkla	0,01755	0,00013	0,00986
Statoil	0,01330	0,00001	0,00130
DNB	0,01114	0,00001	0,00078
Hydro	0,00384	-0,00022	-0,01373
Storebrand	-0,00436	-0,00045	-0,01788
Telenor	0,02920	0,00042	0,02549
Yara	0,01221	0,00009	0,00368
OBX	0,01851	0,00007	0,01437
MarineHarvest	0,02990	0,00070	0,02608
Subsea7	0,00560	-0,00020	-0,00990

Panel B

First 5	Sharpe	Jensen's alpha	IR
Orkla	0,00455	0,00009	0,00605
Statoil	0,00875	0,00018	0,01487
DNB	-0,00106	-0,00006	-0,00275
Hydro	-0,00016	-0,00006	-0,00299
Storebrand	-0,00944	-0,00039	-0,01308
Telenor	0,01948	0,00050	0,02409
Yara	-0,00050	-0,00006	-0,00198
OBX	0,00691	0,00012	0,01938
MarineHarvest	0,02317	0,00085	0,02571
Subsea7	0,01044	0,00030	0,01313

Panel C

Last 5	Sharpe	Jensen's alpha	IR
Orkla	0,04474	0,00025	0,02372
Statoil	0,02534	-0,00010	-0,01086
DNB	0,03239	0,00004	0,00323
Hydro	0,01242	-0,00034	-0,02660
Storebrand	0,00443	-0,00061	-0,03107
Telenor	0,05099	0,00036	0,03223
Yara	0,03791	0,00026	0,01677
OBX	0,04267	0,00002	0,01127
MarineHarvest	0,04526	0,00053	0,02754
Subsea7	-0,00107	-0,00069	-0,04216
Gjensidige	0,08124	0,00086	0,07392

Table 2: Covered combination

The Tables shows Covered combination for all 10 years, first 5, and the last 5 years. The 3 performance measure are Sharpe Ratio, Jensen`s Alpha, and Information ratio.

Panel A

All 10	Sharpe	Jensen's alpha	IR
Orkla	0,01266	0,00004	0,00277
Statoil	0,01622	0,00008	0,00679
DNB	0,01101	0,00002	0,00094
Hydro	0,00246	-0,00026	-0,01518
Storebrand	-0,00624	-0,00053	-0,01932
Telenor	0,02400	0,00035	0,01915
Yara	0,01109	0,00008	0,00286
OBX	0,00810	-0,00009	-0,00488
MarineHarvest	0,03320	0,00082	0,02981
Subsea7	-0,00006	-0,00043	-0,00872

Panel B

First 5	Sharpe	Jensen's alpha	IR
Orkla	-0,00201	-0,00008	-0,00432
Statoil	0,01249	0,00028	0,02101
DNB	-0,00009	-0,00004	-0,00146
Hydro	-0,00024	-0,00006	-0,00300
Storebrand	-0,01423	-0,00061	-0,01855
Telenor	0,01064	0,00030	0,01280
Yara	-0,00451	-0,00024	-0,00685
OBX	-0,00598	-0,00026	-0,01020
MarineHarvest	0,02824	0,00106	0,03121
Subsea7	-0,00491	-0,00046	-0,00683

Panel C

Last 5	Sharpe	Jensen's alpha	IR
Orkla	0,04244	0,00023	0,02084
Statoil	0,02868	-0,00004	-0,00396
DNB	0,03021	0,00001	0,00059
Hydro	0,00685	-0,00046	-0,03254
Storebrand	0,00591	-0,00056	-0,02833
Telenor	0,05577	0,00043	0,03824
Yara	0,04136	0,00035	0,02109
OBX	0,04450	0,00007	0,01584
MarineHarvest	0,04815	0,00063	0,03114
Subsea7	0,00389	-0,00058	-0,03434
Gjensidige	0,08451	0,00090	0,07755

Table 3: Protective put

The Tables shows Protective put for all 10 years, first 5, and the last 5 years. The 3 performance measure are Sharpe Ratio, Jensen`s Alpha, and Information ratio.

Panel A

All 10	Sharpe	Jensen's alpha	IR
Orkla	0,01665	0,00013	0,00889
Statoil	0,00042	-0,00024	-0,02112
DNB	0,01455	0,00014	0,00652
Hydro	0,00288	-0,00023	-0,01364
Storebrand	-0,00514	-0,00047	-0,01775
Telenor	0,02660	0,00039	0,02224
Yara	0,02055	0,00028	0,01390
OBX	0,02360	0,00018	0,02318
MarineHarvest	0,00829	0,00006	0,00197
Subsea7	0,00714	-0,00013	-0,00633

Panel B

First 5	Sharpe	Jensen's alpha	IR
Orkla	0,00573	0,00013	0,00755
Statoil	-0,00471	-0,00014	-0,01109
DNB	0,00338	0,00009	0,00332
Hydro	0,00154	0,00000	0,00005
Storebrand	-0,00527	-0,00024	-0,00742
Telenor	0,01826	0,00049	0,02180
Yara	0,01493	0,00046	0,01867
OBX	0,01967	0,00043	0,03983
MarineHarvest	0,00448	0,00016	0,00483
Subsea7	0,01998	0,00066	0,02605

Panel C

Last 5	Sharpe	Jensen's alpha	IR
Orkla	0,03872	0,00019	0,01721
Statoil	0,00865	-0,00032	-0,03237
DNB	0,03618	0,00016	0,01148
Hydro	0,00408	-0,00046	-0,03496
Storebrand	-0,00676	-0,00091	-0,04461
Telenor	0,04510	0,00028	0,02523
Yara	0,03117	0,00012	0,00818
OBX	0,03101	-0,00008	-0,01679
MarineHarvest	0,02526	0,00010	0,00491
Subsea7	-0,01665	-0,00103	-0,06352
Gjensidige	0,07334	0,00076	0,06521

Table 4: Straddle

The Tables shows Straddle for all 10 years, first 5, and the last 5 years. The 3 performance measure are Sharpe Ratio, Jensen`s Alpha, and Information ratio.

Panel A

10 years	Sharpe	Jensen`s alpha	Information ratio
Orkla	0,00276	0,00009	0,00445
Statoil	0,01225	0,00020	0,01006
DNB	-0,00087	0,00004	0,00210
Hydro	0,00257	0,00011	0,00486
Storebrand	-0,00985	-0,00003	-0,00179
Telenor	-0,00244	-0,00001	-0,00027
OBX	0,00240	0,00010	0,00385
Marine Harvest	0,01595	0,00046	0,01554
Subsea7	0,01492	0,00021	0,01096
Gjensidige	0,02840	0,00030	0,02077

Panel B

First 5	Sharpe	Jensen`s alpha	Information ratio
Orkla	-0,00691	0,00004	0,00170
Statoil	0,00491	0,00012	0,00572
DNB	-0,00360	0,00007	0,00339
Hydro	-0,01607	-0,00007	-0,00302
Storebrand	-0,02068	-0,00003	-0,00165
Telenor	-0,01840	-0,00012	-0,00506
OBX	-0,01092	-0,00005	-0,00213
Marine Harvest	0,00159	0,00011	0,00467
Subsea7	-0,00801	0,00007	0,00315

Panel C

Last 5	Sharpe	Jensen`s alpha	Information ratio
Orkla	0,00977	0,00014	0,00879
Statoil	0,01222	0,00019	0,01162
DNB	-0,00572	-0,00013	-0,00473
Hydro	0,02483	0,00030	0,01846
Storebrand	-0,00147	0,00004	0,00279
Telenor	0,00362	0,00009	0,00462
Yara	-0,00913	-0,00026	-0,00767
OBX	0,01702	0,00024	0,01447
Marine Harvest	0,02606	0,00043	0,02253
Subsea7	0,02461	0,00025	0,01776
Gjensidige	0,02840	0,00030	0,02077

Table 5: Straddle implied volatility excluded.

The Tables shows Straddle implied volatility excluded for all 10 years, first 5, and the last 5 years. The 3 performance measure are Sharpe Ratio, Jensen`s Alpha, and Information ratio.

Panel A

10 years	Sharpe	Jensen`s alpha	Information ratio
Orkla	0,00078	0,00007	0,00259
Statoil	0,01591	0,00030	0,01354
DNB	-0,00125	0,00003	0,00109
Hydro	0,00183	0,00010	0,00387
Storebrand	0,01185	0,00017	0,00914
Telenor	0,00258	0,00012	0,00365
OBX	-0,00019	-0,00019	-0,00172
Marine Harvest	0,01278	0,00058	0,01326
Subsea7	0,00165	0,00011	0,00246
Gjensidige	0,01546	0,00024	0,01386

Panel B

First 5	Sharpe	Jensen`s alpha	Information ratio
Orkla	-0,01145	-0,00005	-0,00206
Statoil	0,00888	0,00017	0,00775
DNB	0,00401	0,00012	0,00553
Hydro	-0,00843	-0,00003	-0,00108
Storebrand	0,00323	0,00011	0,00525
Telenor	-0,00915	-0,00003	-0,00109
OBX	-0,01697	-0,00034	-0,01074
Marine Harvest	0,00682	0,00027	0,00813
Subsea7	-0,01562	-0,00017	-0,00660

Panel C

Last 5	Sharpe	Jensen`s alpha	Information ratio
Orkla	0,01614	0,00025	0,01360
Statoil	0,02859	0,00042	0,02393
DNB	-0,00656	-0,00024	-0,00599
Hydro	0,01550	0,00029	0,01382
Storebrand	0,02284	0,00032	0,01948
Telenor	0,01016	0,00020	0,00886
Yara	-0,00308	-0,00012	-0,00197
OBX	0,02451	0,00039	0,02085
Marine Harvest	0,02255	0,00055	0,02090
Subsea7	0,02055	0,00034	0,01828
Gjensidige	0,01546	0,00024	0,01386

Table 6: Strangle

The Tables shows Stranglefor all 10 years, first 5, and the last 5 years. The 3 performance measure are Sharpe Ratio, Jensen`s Alpha, and Information ratio.

Panel A

10 years	Sharpe	Jensen`s alpha	Information ratio
Orkla	-0,00207	0,00004	0,00221
Statoil	0,01772	0,00016	0,00925
DNB	-0,00226	0,00004	0,00238
Hydro	-0,01204	-0,00010	-0,00479
Storebrand	-0,01608	-0,00003	-0,00145
Telenor	-0,00441	0,00000	0,00019
OBX	-0,00828	-0,00011	-0,00467
Marine Harvest	0,02276	0,00042	0,01855
Subsea7	0,02063	0,00018	0,01046
Gjensidige	0,04714	0,00018	0,01518

Panel B

First 5	Sharpe	Jensen`s alpha	Information ratio
Orkla	-0,01703	-0,00011	-0,00471
Statoil	0,00423	0,00012	0,00557
DNB	-0,00294	0,00007	0,00325
Hydro	-0,02068	-0,00029	-0,01041
Storebrand	-0,02711	-0,00012	-0,00536
Telenor	0,01740	-0,00015	-0,00642
OBX	-0,01796	-0,00033	-0,01151
Marine Harvest	0,00028	0,00010	0,00383
Subsea7	-0,00830	0,00006	0,00304

Panel C

Last 5	Sharpe	Jensen`s alpha	Information ratio
Orkla	0,05777	0,00019	0,01637
Statoil	0,05489	0,00023	0,01884
DNB	-0,00252	-0,00002	-0,00116
Hydro	0,00091	0,00002	0,00148
Storebrand	0,01603	0,00010	0,00843
Telenor	0,00840	0,00009	0,00706
Yara	-0,01015	-0,00013	-0,00647
OBX	0,00782	0,00006	0,00541
Marine Harvest	0,03917	0,00041	0,02780
Subsea7	0,04693	0,00024	0,01932
Gjensidige	0,04714	0,00018	0,01518

Table 7: Strangle implied volatility excluded.

The Tables shows Strangleimplied volatility excluded for all 10 years, first 5, and the last 5 years. The 3 performance measure are Sharpe Ratio, Jensen`s Alpha, and Information ratio.

Panel A

10 years	Sharpe	Jensen`s alpha	Information ratio
Orkla	0,00116	0,00007	0,00352
Statoil	0,03230	0,00026	0,01455
DNB	0,00286	0,00008	0,00456
Hydro	-0,00060	0,00006	0,00280
Storebrand	0,00447	0,00009	0,00526
Telenor	0,00260	0,00009	0,00432
OBX	-0,00261	-0,00004	-0,00130
Marine Harvest	0,02326	0,00062	0,02140
Subsea7	0,00516	0,00017	0,00598
Gjensidige	0,04959	0,00021	0,01803

Panel B

First 5	Sharpe	Jensen`s alpha	Information ratio
Orkla	-0,01099	-0,00005	-0,00234
Statoil	0,02442	0,00027	0,01239
DNB	0,01360	0,00018	0,00865
Hydro	-0,00121	0,00007	0,00278
Storebrand	-0,00232	0,00007	0,00342
Telenor	-0,01053	-0,00007	-0,00270
OBX	-0,01676	-0,00051	-0,01309
Marine Harvest	0,01203	0,00047	0,01255
Subsea7	-0,01528	-0,00041	-0,01102

Panel C

Last 5	Sharpe	Jensen`s alpha	Information ratio
Orkla	0,03975	0,00020	0,01675
Statoil	0,06016	0,00033	0,02692
DNB	-0,00367	-0,00003	-0,00206
Hydro	0,00309	0,00005	0,00337
Storebrand	0,03009	0,00021	0,01660
Telenor	0,01786	0,00016	0,01191
Yara	0,00843	0,00019	0,00898
OBX	0,03738	0,00023	0,01858
Marine Harvest	0,06446	0,00063	0,04359
Subsea7	0,06172	0,00038	0,03012
Gjensidige	0,04959	0,00021	0,01803

Table 8: Butterfly spread

The Tables shows Butterfly spread for all 10 years, first 5, and the last 5 years. The 3 performance measure are Sharpe Ratio, Jensen`s Alpha, and Information ratio.

Panel A

10 years	Sharpe	Jensen`s alpha	Information ratio
Orkla	-0,00923	0,00001	0,00040
Statoil	-0,00748	0,00002	0,00112
DNB	-0,02221	-0,00010	-0,00526
Hydro	-0,00571	0,00004	0,00255
Storebrand	-0,03474	-0,00002	-0,00143
Telenor	-0,00826	-0,00006	-0,00249
Yara	-0,01696	-0,00016	-0,00759
OBX	0,00334	0,00009	0,00508
Marine Harvest	-0,00761	-0,00002	-0,00086
Subsea7	-0,01271	0,00001	0,00068
Gjensidige	-0,02274	-0,00011	-0,00834

Panel B

First 5	Sharpe	Jensen`s alpha	Information ratio
Orkla	-0,01070	0,00001	0,00026
Statoil	-0,02255	0,00002	0,00087
DNB	-0,01261	0,00005	0,00244
Hydro	-0,03729	-0,00003	-0,00169
Storebrand	-0,03230	-0,00003	-0,00139
Telenor	-0,02107	-0,00008	-0,00360
Yara	-0,02183	-0,00002	-0,00076
OBX	-0,01403	0,00003	0,00131
Marine Harvest	-0,02149	0,00002	0,00083
Subsea7	-0,17147	0,00001	0,00034

Panel C

Last 5	Sharpe	Jensen`s alpha	Information ratio
Orkla	-0,00631	0,00001	0,00049
Statoil	-0,00889	-0,00004	-0,00250
DNB	-0,02981	-0,00031	-0,01914
Hydro	0,01209	0,00012	0,00895
Storebrand	-0,07483	-0,00004	-0,00335
Telenor	-0,00806	-0,00005	-0,00303
Yara	-0,02130	-0,00015	-0,01040
OBX	0,00802	0,00010	0,00734
Marine Harvest	-0,01118	-0,00003	-0,00210
Subsea7	-0,00867	0,00000	0,00023
Gjensidige	-0,02274	-0,00011	-0,00834

Table 9: Butterfly spread implied volatility excluded.

The Tables shows Butterfly spread implied volatility excluded for all 10 years, first 5, and the last 5 years. The 3 performance measure are Sharpe Ratio, Jensen`s Alpha, and Information ratio.

Panel A

10 years	Sharpe	Jensen`s alpha	Information ratio
Orkla	-0,01356	-0,00006	-0,00335
Statoil	-0,00982	-0,00003	-0,00176
DNB	-0,01986	-0,00037	-0,01342
Hydro	-0,01663	-0,00006	-0,00341
Storebrand	-0,00831	0,00002	0,00108
Telenor	-0,00898	-0,00023	-0,00611
OBX	-0,00290	0,00002	0,00112
Subsea7	-0,01997	-0,00013	-0,00657
Gjensidige	-0,03245	-0,00028	-0,01858

Panel B

First 5	Sharpe	Jensen`s alpha	Information ratio
Orkla	-0,00805	0,00001	0,00025
Statoil	-0,02611	-0,00009	-0,00436
DNB	-0,02495	-0,00003	-0,00150
Hydro	-0,01171	0,00000	-0,00020
Storebrand	-0,01368	-0,00001	-0,00062
Telenor	-0,02970	-0,00019	-0,00856
Yara	-0,02794	-0,00016	-0,00699
OBX	-0,02164	-0,00014	-0,00593
Marine Harvest	0,00708	0,00018	0,00748
Subsea7	-0,03901	-0,00007	-0,00323

Panel C

Last 5	Sharpe	Jensen`s alpha	Information ratio
Orkla	-0,02235	-0,00021	-0,01329
Statoil	-0,00158	0,00003	0,00153
DNB	-0,02358	-0,00076	-0,02163
Hydro	-0,02038	-0,00018	-0,01165
Storebrand	0,00861	0,00008	0,00647
Telenor	-0,00870	-0,00012	-0,00505
Yara	-0,02793	-0,00061	-0,02358
OBX	0,00623	0,00011	0,00669
Marine Harvest	-0,01800	-0,00038	-0,01584
Subsea7	-0,02098	-0,00010	-0,00753
Gjensidige	-0,03245	-0,00028	-0,01858

Table 10: Long stock

The table shows the Long stock for all 10 years, first 5, and the last 5 years. The 3 performance measure are Sharpe Ratio, Jensen`s Alpha, and Information ratio.

Panel A

10 Years	Sharpe	Jensen's alpha	IR
Orkla	0,01362	0,00005	0,00395
Statoil	0,00688	-0,00011	-0,01086
DNB	0,01336	0,00007	0,00366
Hydro	0,00124	-0,00029	-0,01817
Storebrand	-0,00648	-0,00052	-0,02101
Telenor	0,02638	0,00036	0,02205
Yara	0,02183	0,00030	0,01536
OBX	0,01597	0,00001	0,00934
MarineHarvest	0,02411	0,00053	0,01952
Subsea7	0,00183	-0,00031	-0,01582

Panel B

First 5	Sharpe	Jensen's alpha	IR
Orkla	-0,00016	-0,00002	-0,00147
Statoil	0,00225	0,00003	0,00231
DNB	0,00080	-0,00001	-0,00024
Hydro	-0,00245	-0,00013	-0,00685
Storebrand	-0,00942	-0,00038	-0,01330
Telenor	0,01436	0,00036	0,01787
Yara	0,01357	0,00040	0,01733
OBX	0,00421	0,00006	0,03513
MarineHarvest	0,01790	0,00066	0,01984
Subsea7	0,00886	0,00024	0,01079

Panel C

Last 5	Sharpe	Jensen's alpha	IR
Orkla	0,04039	0,00019	0,01803
Statoil	0,01506	-0,00025	-0,02785
DNB	0,03573	0,00009	0,00707
Hydro	0,00763	-0,00043	-0,03489
Storebrand	-0,00249	-0,00078	-0,04004
Telenor	0,05271	0,00037	0,03417
Yara	0,03843	0,00023	0,01585
OBX	0,03909	-0,00003	-0,02828
MarineHarvest	0,03628	0,00032	0,01688
Subsea7	-0,00912	-0,00087	-0,05397
Gjensidige	0,07809	0,00082	0,07043

Table 11: Average risk-adjusted performance measures

Panel A: Sharpe ratio

Rank:	Name:	Mean:
1	Covered call	0,01369
2	Long stock	0,01187
3	Strangle NOIMP	0,01182
4	Protective put	0,01156
5	Covered combination	0,01125
6	Straddle	0,00661
7	Strangle	0,00631
8	Straddle NOIMP	0,00614
9	Butterfly	-0,01312
10	Butterfly NOIMP	-0,01472

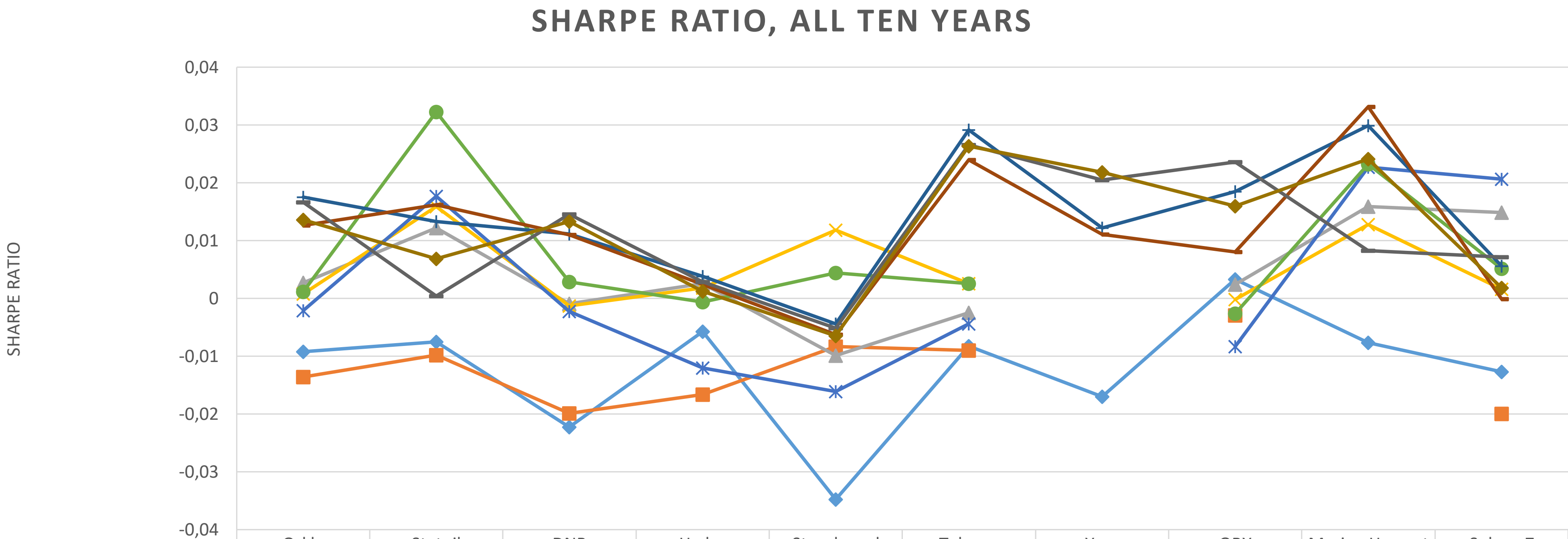
Panel B: Jensen's alpha

Rank:	Name:	Mean:
1	Strangle NOIMP	0,00016
2	Straddle NOIMP	0,00015
3	Straddle	0,00015
4	Strangle	0,00008
5	Covered call	0,00006
6	Protective put	0,00001
7	Covered combination	0,00001
8	Long stock	0,00001
9	Butterfly	-0,00003
10	Butterfly NOIMP	-0,00012

Panel C: Information ratio:

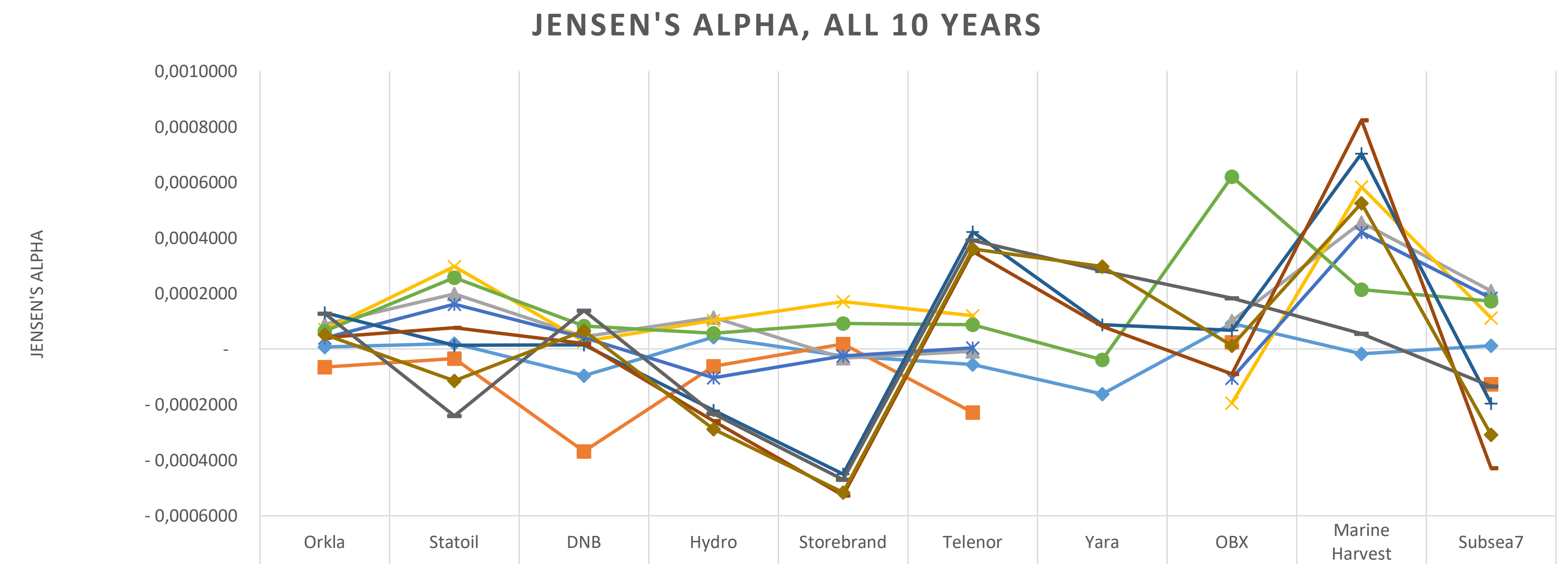
Rank:	Name:	Mean:
1	Straddle	0,01855
2	Straddle NOIMP	0,00000
3	Strangle NOIMP	0,00000
4	Strangle	-0,00027
5	Long stock	-0,00109
6	Butterfly	-0,00147
7	Covered combination	-0,00488
8	Butterfly NOIMP	-0,00567
9	Protective put	-0,01775
10	Covered call	-0,01788

Table 12: Sharpe ratio



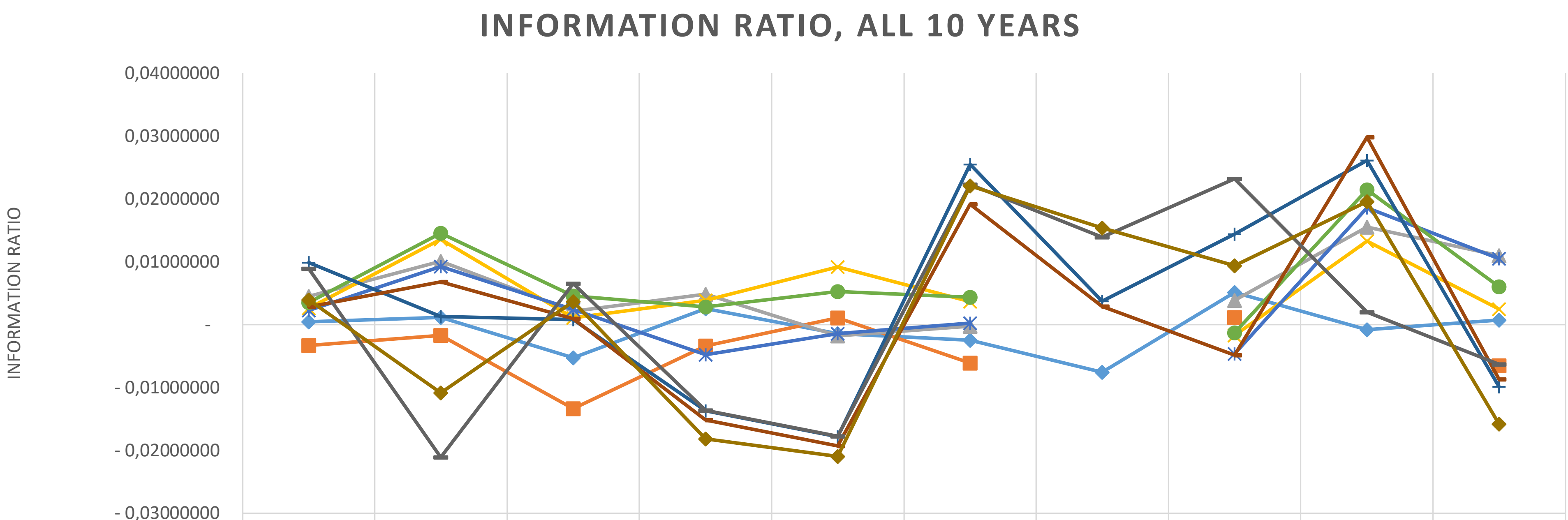
	Orkla	Statoil	DNB	Hydro	Storebrand	Telenor	Yara	OBX	Marine Harvest	Subsea7
Butterfly	-0,009227757	-0,007477297	-0,022209667	-0,005709645	-0,034744864	-0,00825949	-0,016957725	0,00334023	-0,007607557	-0,012706194
Butterfly NOIMP	-0,013560531	-0,009820839	-0,019856996	-0,01663027	-0,008306786	-0,008982528		-0,00290319		-0,019974401
Straddle	0,002763184	0,01224977	-0,000871334	0,002566169	-0,009845527	-0,002444135		0,002403316	0,015953407	0,014915573
Straddle NOIMP	0,00078343	0,015913384	-0,001251418	0,001825883	0,011852293	0,002579171		-0,000189696	0,012782886	0,001647542
Strangle	-0,002065123	0,017716713	-0,002258861	-0,012040278	-0,016079996	-0,004412417		-0,00827505	0,022761482	0,020633229
Strangle NOIMP	0,001156491	0,03230481	0,002861202	-0,000595668	0,004469397	0,00260378		-0,002614342	0,023262555	0,005164335
Covered call	0,017545107	0,013304385	0,011143014	0,003841327	-0,004356666	0,029195856	0,012213732	0,018506904	0,029900845	0,005604432
Covered combination	0,012660	0,016218	0,011013	0,002463	-0,006241	0,024001	0,011094	0,008099	0,033201	-0,000058
Protective put	0,016650242	0,000423953	0,014554894	0,002882698	-0,005139843	0,026603074	0,020550005	0,023599161	0,008290184	0,007142493
Long stock	0,013620843	0,006876854	0,013357737	0,001238539	-0,0064823	0,026384752	0,021834419	0,015967438	0,024107031	0,001831577

Table 13: Jensen's alpha



	Orkla	Statoil	DNB	Hydro	Storebrand	Telenor	Yara	OBX	Marine Harvest	Subsea7
Butterfly	0,0000072	0,0000198	- 0,0000951	0,0000435	- 0,0000241	- 0,0000552	- 0,0001615	0,0000927	- 0,0000169	0,0000116
Butterfly NOIMP	- 0,0000650	- 0,0000343	- 0,0003676	- 0,0000624	0,0000190	- 0,0002285		0,0000247		- 0,0001260
Straddle	0,0000890	0,0001980	0,0000449	0,0001139	- 0,0000332	- 0,0000080		0,0001019	0,0004562	0,0002090
Straddle NOIMP	0,0000700	0,0002980	0,0000274	0,0001038	0,0001705	0,0001204		- 0,0001936	0,0005833	0,0001120
Strangle	0,0000397	0,0001620	0,0000419	- 0,0001031	- 0,0000253	0,0000038		- 0,0001055	0,0004201	0,0001828
Strangle NOIMP	0,0000650	0,0002570	0,0000825	0,0000567	0,0000917	0,0000877	- 0,0000386	0,0006208	0,0002144	0,0001723
Covered call	0,0001306	0,0000140	0,0000145	- 0,0002206	- 0,0004500	0,0004214	0,0000875	0,0000678	0,0007044	- 0,0001965
Covered combination	0,0000412	0,0000774	0,0000198	- 0,0002585	- 0,0005263	0,0003506	0,0000815	- 0,0000890	0,0008239	- 0,0004280
Protective put	0,0001271	- 0,0002403	0,0001389	- 0,0002325	- 0,0004704	0,0003911	0,0002823	0,0001835	0,0000555	- 0,0001349
Long stock	0,0000523	- 0,0001142	0,0000667	- 0,0002881	- 0,0005160	0,0003609	0,0002967	0,0000126	0,0005259	- 0,0003089

Table 14: Information ratio



	Orkla	Statoil	DNB	Hydro	Storebrand	Telenor	Yara	OBX	Marine Harvest	Subsea7
Butterfly	0,00040167	0,00112202	- 0,00526183	0,00254556	- 0,00143155	- 0,00248528	- 0,00758915	0,00508029	- 0,00085833	0,00068303
Butterfly NOIMP	- 0,00334805	- 0,00176378	- 0,01342038	- 0,00341175	0,00108295	- 0,00611257		0,00112408		- 0,00656601
Straddle	0,00445058	0,01005734	0,00210368	0,00485892	- 0,00179102	- 0,00027304		0,00384579	0,01553759	0,01095742
Straddle NOIMP	0,00259267	0,01354494	0,00108947	0,00386938	0,00914213	0,00365210		- 0,00171655	0,01325695	0,00246197
Strangle	0,00221115	0,00924577	0,00238024	- 0,00478624	- 0,00145279	0,00019352		- 0,00467157	0,01854624	0,01046360
Strangle NOIMP	0,00351779	0,01454820	0,00455886	0,00279516	0,00526293	0,00432429		- 0,00130342	0,02140317	0,00598215
Covered call	0,00986105	0,00129880	0,00077670	- 0,01372791	- 0,01788311	0,02549375	0,00367649	0,01436733	0,02608406	- 0,00989885
Covered combination	0,00277200	0,00679138	0,00094041	- 0,01518147	- 0,01932051	0,01914703	0,00286236	- 0,00488040	0,02980717	- 0,00871833
Protective put	0,00888846	- 0,02111652	0,00652081	- 0,01364083	- 0,01775486	0,02224090	0,01389532	0,02318065	0,00196806	- 0,00632534
Long stock	0,00395102	- 0,01086276	0,00366043	- 0,01816948	- 0,02100529	0,02205155	0,01536266	0,00933654	0,01952112	- 0,01581648

Table 15: Descriptive statistics for all 10 years, and both

2005-2015	OBX	Statoil	Hydro	DNB	Marine Harvest	Orkla	Storebrand	Subsea 7	Telenor	Yara	Gjensidige
Number of months	120	120	120	120	120	120	120	120	120	120	60
Mean (%)	0,030 %	0,020 %	0,010 %	0,040 %	0,160 %	0,030 %	-0,010 %	0,010 %	0,060 %	0,070 %	0,070 %
Standard Deviation (%)	1,740 %	1,960 %	2,540 %	2,540 %	5,550 %	1,990 %	3,140 %	2,920 %	2,020 %	2,660 %	1,350 %
Skewness	-0,536	-0,286	-0,099	-0,123	28,982	-0,040	-0,213	-0,282	-1,226	-0,378	-0,38
Excess Kurtosis	6,364	4,296	6,379	10,043	1207,578	8,816	6,868	3,459	23,168	5,578	6,63
Jarque-Bera Statistic	4359,300	1965,800	4263,000	10563,000	152980000,000	8135,200	4967,600	1289,000	56913,000	3324,600	2124,40
Probability of Normal(JB)	2.2e-16	2.2e-16	2.2e-16	2.2e-16	2.2e-16	2.2e-16	2.2e-16	2.2e-16	2.2e-16	2.2e-16	2.2e-16
Probability of Normal(Skew)	2.2e-16	2.2e-16	0.039	0.013	2.2e-16	0.418	2.2e-16	2.2e-16	2.2e-16	2.2e-16	2.2e-16

2005-2010	OBX	Statoil	Hydro	DNB	Marine Harvest	Orkla	Storebrand	Subsea 7	Telenor	Yara	Gjensidige
Number of months	60	60	60	60	60	60	60	60	60	60	0
Mean (%)	0,020 %	0,020 %	0,002 %	0,010 %	0,070 %	0,010 %	-0,030 %	0,040 %	0,050 %	0,060 %	NA
Standard Deviation (%)	2,160 %	2,370 %	3,100 %	3,090 %	3,690 %	2,470 %	3,650 %	3,480 %	2,530 %	3,260 %	NA
Skewness	-0,516	-0,308	-0,073	-0,070	0,256	0,003	-0,166	-0,293	-1,238	-0,392	NA
Excess Kurtosis	4,449	3,102	4,909	8,151	5,205	5,971	6,285	2,445	18,000	4,075	NA
Jarque-Bera Statistic	1092,200	523,890	1263,100	3840,400	1432,700	1867,100	2074,400	331,050	17291,000	901,940	NA
Probability of Normal(JB)	2.2e-16	2.2e-16	2.2e-16	2.2e-16	2.2e-16	2.2e-16	2.2e-16	2.2e-16	2.2e-16	2.2e-16	NA
Probability of Normal(Skew)	2.2e-16	2.2e-16	0,2785	0,321	0,0005	0,9595	0,0155	2.2e-16	2.2e-16	2.2e-16	NA

2010-2015	OBX	Statoil	Hydro	DNB	Marine Harvest	Orkla	Storebrand	Subsea 7	Telenor	Yara	Gjensidige
Number of months	60	60	60	60	60	60	60	60	60	60	60
Mean (%)	0,050 %	0,030 %	0,020 %	0,070 %	0,240 %	0,060 %	-0,001 %	-0,020 %	0,080 %	0,080 %	0,070 %
Standard Deviation (%)	1,190 %	1,430 %	1,820 %	1,830 %	6,920 %	1,350 %	2,520 %	2,220 %	1,330 %	1,870 %	1,350 %
Skewness	-0,200	-0,048	-0,150	-0,230	29,795	-0,143	-0,302	-0,210	-0,033	-0,056	-0,382
Excess Kurtosis	2,565	2,316	1,889	3,155	994,743	8,390	3,554	2,754	2,166	1,578	6,650
Jarque-Bera Statistic	352,620	281,170	191,470	531,890	51970000,000	3687,700	680,140	406,060	245,860	130,940	2124,400
Probability of Normal(JB)	2.2e-16	2.2e-16	2.2e-16	2.2e-16	2.2e-16	2.2e-16	2.2e-16	2.2e-16	2.2e-16	2.2e-16	2.2e-16
Probability of Normal(Skew)	0,0035	0,4815	0,0325	0,0005	2.2e-16	0,038	2.2e-16	0,0025	0,653	0,4285	2.2e-16